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**SELECTIONS FROM THE RECORDS OF THE BOMBAY
GOVERNMENT.**

IRRIGATION SERIES.—No. VII.

P A P E R S 110035

RELATING TO THE

MITROW CANAL

IN THE

EASTERN NARRA DISTRICTS, SIND,

WITH PLANS AND ESTIMATES

OF

ROADS, BRIDGES, &c.

MAP & PLANS IN A SEPARATE CASE.

Bombay:

PRINTED FOR GOVERNMENT

AT THE EDUCATION SOCIETY'S PRESS, BYCULLA.

1867.

ESTIMATE No. 19 OF 1866.

*Agricultural
Irrigation Canal.*

PUBLIC WORKS DEPARTMENT.

REVISED ESTIMATE framed by Lieutenant J. D. CRUICKSHANK, R.E.,
*Acting Executive Engineer Mitrow Canal, of the probable cost
of the Mitrow Canal when finished, with all its Branch Canals
and their Regulating Bridges, Road Bridges over the Canal,
and Branches, Masonry Kurriah Heads, &c.*

Amount of Estimate Rs. 5,52,332.

GENERAL DESCRIPTION.

In the original design the Mitrow Canal was divided into two parts, running from the Mukkee Dund, from near the small and unimportant village of Mitrow, to Humeerow, a distance of 60 miles. The next section of the Canal was its extension from the village of Humeerow to Jooda on the Pooran river. At the 62nd mile there was to be a masonry escape, and a small channel had to be dug half a mile in length to convey the surplus water into a Dhora or old branch of the river at Kurora. From the 75th mile a branch was to be excavated in the direction of Gabraila, the length of this branch being nine miles. In the first section the necessary works besides the excavation of the Canal itself were enumerated as follows, viz :—

	Estimated Amount.		
	Rs.	a.	p.
A weir to be thrown across the Oowud from the Bakhora to Sabooka, with a passage for boats constructed in it . . .	43,944	0	0
A bund to be constructed on the high ground from Bakhora in a north-west direction	10,387	0	0
Regulating bridge of 5 openings at head of Canal	8,539	0	0
Four Road Bridges as follows:—			
Bridge, 55 feet waterway, for the Mitha Khan-ka-Tanda and Shahdadpoor road.	4,611	0	0
Carried over. . . . Rs.	67,481	0	0

	Estimated Amount.		
	Rs.	a.	p.
Brought over....	67,481	0	0
Bridge, 40 feet waterway, for Meerpoor and Kipra road	4,927	0	0
Bridge, 32½ feet waterway, for Meerpoor and Oomerkote road	3,675	0	0
Bridge, 25 feet waterway, for the Samara road	3,164	0	0
Masonry Kurriah heads, one for each mile = 60, at Rs. 150 each.....	9,000	0	0
336 Modules, at Rs. 42 each	14,112	0	0
Total....	1,02,359	0	0
Add for excavation of Canal.....	2,50,557	0	0
Grand Total for 1st Section....	Rs. 3,52,916	0	0

In the 2nd section, or as it is called in the estimate, constructing the tail of the Mitrow Canal from the village of Humeerow to Jooda on the Pooran river, the necessary works, besides the excavation of the Canal itself and the Gabraila branch, were described as follows, viz :—

	Estimated Amount.		
	Rs.	a.	p.
Escape at the 62nd mile near Kurora	1,624	11	9
2 Bridges, of 8 feet waterway each, on the road from Jooda to Nubeesir, at Rs. 389-12-9 each	779	9	6
Lock connecting the Mitrow Canal with the Silhoorwah at Hingornah	5,591	1	7
38 Masonry heads to Distributing Channels, at Rs. 150 each	5,700	0	0
224 Modules, at Rs. 42 each	9,408	0	0
Total....	23,103	6	10
Add for excavation of Canal and Branch.	46,917	9	2
Grand Total....	70,021	0	0
Add cost of 1st Section	3,52,916	0	0
Grand Total of Estimate....	Rs. 4,22,937	0	0

The description of the 1st Section is as follows in the original estimate, viz:—

The Canal to have a width at bottom of 44 feet at head, and to be gradually reduced in width towards its tail, and to be constructed to convey a stream of water 6 feet deep; the slopes to be $1\frac{1}{2}$ to 1; masonry heads to be constructed for the whole of the distributing channels. The exact number of these channels will be determined hereafter. For the present one is allowed for each mile in length of canal. Masonry modules to be built on the banks of the distributing channels. The numbers cannot yet be determined, but one module has been allowed for every cubic foot of discharge. The necessary masonry works enumerated above are then given.

Of the 2nd Section the description is as follows, viz:—

The dimensions of the Canal at Humeerow were—width at bottom $15\frac{1}{2}$ feet, depth 6 feet, and slope $1\frac{1}{2}$ in 1. From the 60th mile to the 76th the width will be gradually reduced to $6\frac{1}{2}$ at bottom, but the depth (6 feet) will remain the same. At the end of 76th mile, where the branch running past Gabraila is thrown off, the depth to be reduced to 4 feet, and at the end of 79th mile to 3 feet, the width being proportional to the discharge, which is reduced at the rate of 6 feet per second per mile. The Gabraila branch to be 3 feet in depth; width proportional to discharge. The towing paths of the main line to be 10 feet wide, and 2 feet above water line. In the Gabraila branch the paths to be 4 feet wide. Masonry head to the distributing channels and also modules are allowed at the same rate of calculation as for the 1st Section, and the masonry works enumerated above are there given.

To describe the course of the Mitrow Canal as it has been laid out and excavated up to the present—

The first sod (speaking figuratively) of this Canal was turned in the month of March 1859, Mr. J. Barnes, C.E., being the Executive Officer in charge of this important Canal. The line of Canal was followed according to the original design as far as the 53rd mile—the extreme limit to which the original pegs marking the centre line could be found.

From that point onward the line had to be re-surveyed and re-levelled. The line now passes at the 62nd mile about two miles to the east of Humeerow and crosses the Dhora (old bed or channel of the river) at the 66th mile near the village of the Kurora, and about six miles to the west of a large town called Samarah. The masonry escape provided for at Humeerow in the original estimate will be required now at this point. Beyond Kurora the line passes no places worth mentioning, only small "chunns" or natural hollows filled with rain-water, inhabited by a few people who generally have to emigrate at the end of January on account of the water drying up, till the 78th mile, where it passes at the nearest point about $1\frac{1}{2}$ or 2 miles to the west of a rather large village called Churr. The Canal then turns rather to the westward, and at the 82nd mile passes between the villages of Durraila and Kooreah, these villages being about 3 miles apart, and the latter having a good many inhabitants. The Canal will run for 6 miles more, tailing off into another old channel of the river. The line thus passes well to the eastward of the original design, and the branch canal to Gabraila will not now be required, or at any rate for some time to come, and until some more levels of that part of the country can be procured. It may not be out of place here to mention that there have been three different officers in charge of this work since its commencement, and considering the extent of it, it is not surprising that as the Canal progressed some modifications of or additions to the original design have been found necessary—modifications or additions involving most likely extra expense in each case. The officers alluded to are Mr. J. Barnes, C.E., Captain J. LeMesurier, R.E., and Lieutenant F. J. Smith, R.E., who was in charge of this work up to 30th June last. We will now consider the actual cost of the works carried out, and which were estimated for in the original design, with their estimated amounts, and in the accompanying table the saving or excess will be seen at once:—

Description of Work.	Amount in original Estimate.	EXPENDITURE.				Saving.	Excess.
		Already Expended.	Required for Completion.	Total.			
1	2	3	4	5	6	7	
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
Excavating Canal, including							
Gabraila Branch	2,97,474 6 1	2,70,461 6 5	62,732 14 6	3,33,194 4 11	....	35,719 14 10	
Jullub Bund	10,387 0 0	10,753 12 5	.....	10,753 12 5	....	366 12 5	
Weir across Oowud or Mukkee ..	43,944 0 0	47,264 8 7	.....	47,264 8 7	....	3,320 8 7	
Regulating Bridge at Bakhora ..	8,539 0 0	17,698 11 0	.....	17,698 11 0	....	9,159 11 0	
Masonry Bridge on Road from							
Mitta Khan-ka-Tanda to Shah-							
dadpoor	4,611 0 0	6,398 13 4	.....	6,398 13 4	....	1,787 13 4	
Do. do. Meerpoor and Kipra							
Road	4,927 0 0	6,588 5 10	230 0 0	6,818 5 10	....	1,891 5 10	
Do. do. Meerpoor and Oo-							
merkote Road	3,675 0 0	5,174 2 0	.....	5,174 2 0	....	1,499 2 0	
Do. do. Samara and Gor-							
channee	3,164 0 0	2,230 9 9	1,700 0 0	3,930 9 9	....	766 9 9	
Do. do. Jooda to Nubeesir	389 12 9	.....	.....	.....	389 12 9	....	
Do. do.	389 12 9	.....	.....	.....	389 12 9	....	
Escape at Kurora	1,624 11 9	.....	2,466 14 11	2,466 14 11	....	842 3 2	
Masonry Heads to Kurriahs	14,700 0 0	11,713 6 2	39,039 5 2	50,752 11 4	....	36,052 11 4	
Modules for selling water.	23,520 0 0	.....	.....	.....	23,520 0 0	....	
Lock into Silhonah	5,591 1 7	.....	.....	.....	5,591 1 7	....	
Extra Establishment and Contin-							
gencies* .....	.....	.....	.....	.....	.....	....	
Total.... Rupees	4,22,936 12 11	3,78,283 11 6	1,06,169 2 7	4,84,452 14 1	1,29,890 11 1	91,406 12 3	

* Entered under the head of "Miscellaneous Works."

The amount entered as already expended on the excavation of the Canal includes the amount paid for excavation on branches such as the Samarah branch at the 57th mile, &c. which extra work has been duly sanctioned* by the Chief Engineer in Sind before being undertaken; but this amount does not include the unadjusted balance of advances to contractors for the earthwork. Under the head of extra establishment and contingencies are included the cost of building a bungalow and outhouses† at Bakhora for the use of the Executive Engineer, as also a smaller bungalow ‡ for the accommodation of the Moonshee in charge of the Regulating Bridge, and also for the storage of stores.§ A bungalow and outhouses¶ have also been constructed at Sindree, 27th mile of the Canal, for the Executive Engineer, as also a small house for the stores and Storekeeper. There is also accommodation provided for the Accountant and Moonshees of this office, and Sindree is now considered the district head-quarters.

As the work progressed, and the Canal lengthened out, it became evident that there were not enough bridges across the canals, and the following additional bridges have been constructed, viz. 8th, 12th, 14th, 18th, 20th, 24th, 27th, 33rd, 36th, 40th, 48th, 52nd, 57th, and 65th miles, the bridge in the 57th mile having been recently finished, while in the bridges originally sanctioned some alterations had to be made. The following bridges will be required on the main line, viz. 69th, 73rd, 76th, 79th, 83rd, and 86th miles, and a sluice at the tail. These finished bridges are of masonry and wood-work. Near the end of 57th mile a branch canal is thrown off towards the town of Samarah to irrigate some land which the water of the main line would not touch on account of an intervening high ridge of ground. This branch was not contemplated in the original design, and the execution of it was sanctioned by the Chief Engineer, the amount of its estimate to be included in this supplementary estimate. Up to 30th April last many masonry kurriah heads were finished, and some were left unfinished on account of the water coming

* C. E. No. 1732 of 13th May 1865.

† C. E. No. 216 of 4th March 1866.

‡ C. E. No. 326 of 12th March 1861.

§ C. E. No. 3133 of 23rd November 1863.

¶ C. E. No. 2869 of 21st October 1861.

into the Canal. In the original estimate these were estimated at Rs. 150 each, and one head in each mile, but experience has shown that they cannot be executed for that small sum, and there are more kurriah heads to be constructed than one in each mile. In the following measurements the works which were originally sanctioned, and have been undertaken, are taken in their order in the original estimate, and afterwards the new and additional works:—

Measurements—Excavating Canal.

Miles	Mean Bottom Breadth.	Mean Top Breadth.	Mean Depth.	Solid Feet.	REMARKS.
1	44-00	55-73	7-82	20,58,699-456	
2	44-00	53-78	6-52	16,83,067-534	
3	44-00	52-86	5-91	15,11,247-408	
4	44-00	52-79	5-86	14,97,125-312	
5	44-00	53-09	6-06	15,53,284-656	
6	44-00	51-29	4-86	12,22,608-816	
7	44-00	51-83	5-22	13,20,614-064	
8	44-00	53-75	6-50	16,77,390-000	
9	43-50	56-35	8-57	22,58,860-320	
10	43-25	54-42	7-45	19,20,776-880	
11	42-75	53-04	6-86	17,34,614-112	
12	42-25	53-66	7-14	18,41,171-860	
13	41-75	50-06	5-54	13,42,630-680	
14	41-25	49-83	5-72	13,75,380-864	
15	40-75	49-16	5-61	13,31,454-960	
16	40-25	49-22	5-98	14,13,322-910	
17	40-00	51-71	7-81	18,90,707-280	
18	33-50	46-82	5-55	12,50,103-640	The Rajwah takes off this mile (to the west).
19	38-50	45-39	4-86	5,47,827-456	} For the first 4 furlongs.
	37-50	46-12	5-75	6,34,675-800	
20	36-50	46-28	6-52	14,24,876-584	} " " last " "
21	36-50	45-80	6-20	5,05,157-400	} For the first 3 " "
	35-50	42-89	4-93	6,17,532-110	
22	35-50	42-65	4-77	4,92,000-690	} " " last 5 " "
	34-50	42-04	5-03	5,10,850-824	
23	35-00	42-38	4-92	1,82,070-504	} For the first 4 " "
	34-50	40-69	4-13	5,12,314-110	
24	34-50	40-52	4-18	4,12,455-776	} " " last 5 " "
	34-25	40-88	4-48	4,43,756-544	
25	34-166	40-41	4-44	8,69,273-856	} For the first half mile.
	33-75	39-74	4-33	8,34,248-976	
26	33-25	40-30	5-30	10,21,975-680	} " " last " "
27	32-75				

Miles	Mean Bottom Breadth.	Mean Top Breadth.	Mean Depth.	Solid Feet.	REMARKS.
28	32.25	40.66	5.61	11,61,471.900	} For the first 6 furlongs. " " last 2 "
29	31.75	42.37	7.08	13,85,391.740	
30	31.25	42.30	7.37	14,30,853.072	
31	30.75	41.67	7.28	10,43,602.560	
"	30.50	42.90	8.27	3,99,758.568	
32	30.00	40.39	6.93	12,87,616.286	
33	29.50	39.35	6.57	11,94,015.962	
34	29.00	36.83	5.22	9,03,430.336	
35	28.50	39.00	6.70	11,93,940.000	
36	28.00	37.18	6.12	10,53,100.224	
37	27.50	36.21	5.81	2,77,056.080	
38	27.00	34.86	5.24	8,55,746.496	
39	26.50	34.50	5.76	9,27,590.400	
40	26.00	35.97	6.25	10,87,769.700	
41	25.50	36.30	7.20	11,74,693.400	
42	25.00	35.09	6.73	10,09,932.376	
43	24.50	32.21	5.14	7,69,558.411	
44	24.00	31.18	4.79	6,86,696.208	
45	23.50	32.35	5.90	6,05,732.160	
46	23.00	31.55	5.79	8,20,717.920	
47	22.50	32.62	6.75	9,71,150.400	
48	22.00	31.33	6.22	8,75,557.056	
49	21.50	30.63	6.09	8,37,964.512	
50	21.00	29.50	5.47	7,29,260.400	
51	20.50	27.56	4.71	5,97,597.264	
52	20.00	29.16	6.11	7,92,970.464	
53	19.50	29.03	6.39	8,30,085.168	
54	19.25	30.36	7.40	9,69,180.960	
55	18.75	23.17	6.28	7,77,896.064	
56	18.25	29.78	7.69	9,75,035.848	
57	17.75	29.19	7.63	9,45,521.803	} Samarab Branch takes off in the 7th furlong.
58	14.25	22.87	5.75	5,63,501.600	
59	13.75	21.44	5.13	4,76,585.208	
60	13.50	22.48	5.99	5,68,973.328	
61	13.00	23.24	6.83	6,53,450.688	
62	12.75	26.26	9.01	9,28,143.328	
63	12.50	26.53	9.39	9,63,777.568	
64	12.50	25.85	8.90	9,50,836.640	
65	12.00	26.52	9.68	9,84,386.304	
66	12.00	23.61	7.74	7,27,640.496	
67	12.00	23.67	7.78	7,32,633.264	
68	12.00	22.47	6.98	6,55,001.312	
69	11.75	20.99	6.16	5,32,440.972	
70	11.25	19.12	5.25	4,20,636.600	
71	10.75	21.01	6.91	5,79,378.624	

Miles	Mean Bottom Breadth.	Mean Top Breadth.	Mean Depth.	Solid Feet.	REMARKS.
72	10-25	17-43	4-79	350,030-208	For the first 3 furlongs, at this point the Durraila Branch will take off.
73	9-75	18-87	6-08	459,385-344	
74	9-25	18-17	5-95	430,713-860	
75	8-75	17-97	6-13	433,825-920	
76	8-25	17-67	6-28	430,230-240	
77	7-75	18-59	7-23	502,756-848	
78	7-25	17-21	6-64	423,774-016	
79	6-875	15-765	5-93	132,912-648	
„	5-000	12-09	4-73	133,378-905	
80	4-75	11-69	4-63	200,949-408	
81	4-25	12-92	5-78	262,000-464	
82	4-00	9-92	3-95	139,877-760	
83	4-00	10-94	4-63	182,614-608	
84	4-00	11-66	5-11	211,259-664	
85	4-00	10-66	4-44	171,833-716	
86	4-00	10-01	4-01	148,315-464	
87	4-00	10-00	Probable 4-00	1,47,840-000	These last two miles not yet lined out or levelled.
88	4-00	9-25	Probable 3-50	1,22,337-600	
Total . . .				81,799,552-52	
Deduct amount already excavated, as per table at page 20				64,729,373-52	
Grand total solid feet Excavation remaining to be performed ..				17,070,179-00	

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
1,70,70,179-00 solid feet....	Excavating earthwork at Rs. 3-8-0 per 100 solid feet	59,745 10 0
Total.....		59,745 10 0
<i>Add</i> —Contingencies at 5 per Cent.....		2,987 4 6.
Grand Total....Rs.		62,732 14 6

BUND ALONG THE HIGH LAND FROM BAKHORA, COMMONLY CALLED THE JULLUB BUND.

GENERAL DESCRIPTION.

This Bund starts from Bakhora, from near the Regulating Bridge at head of Mitrow Canal, in a N.W. direction, and terminates at the sand hills near the village of Randero Wassan, about 8 miles distant. Its object is to dam back the water from the Mukkee Dund, to prevent the low ground from being flooded from an overflow, and also to assist in throwing a greater supply of water down the Mitrow Canal. This Bund has been constructed of earth well rammed, the material having been taken from the front, the slopes varying from $1\frac{1}{2}$ in 1 to $1\frac{1}{2}$ in 2 according to the height of the Bund.

The measurements and value of the work performed on this Bund are given in the following page:—

ABSTRACT.

Quantities.	Description of Work performed.	Value of Work done.
		Rs. a. p.
3,697,423 solid feet	Earthwork for embankment well rammed and watered	9,457 14 6
	Materia's, brushwood, &c.	176 13 8
	Establishment (extra)	690 13 6
	Contingencies	428 2 9
	Total....	10,753 12 5
	Estimated amount....	10,337 0 0
	Excess over Estimate....Rs.	366 12 5

REGULATING BRIDGE AT THE HEAD OF THE CANAL
AT BAKHORA.

GENERAL DESCRIPTION.

An amended design for this bridge was submitted by Lieutenant (now Captain) J. LeMesurier, R.E., then Executive Engineer Lower Narra, in December 1860, and approved of by the late Captain Soady, R.E., then Acting Superintendent of Canals. The bridge consists of 5 arches of 11 feet span each, the piers being 3 feet thick, and the abutments 4' 3" at springing line, and 5' 6" at level of flooring. The water-wings are 3 feet thick at the pavement level and 2 feet thick at top, the up-stream waterways being 8 feet high and the down-stream 6' 6" high. The wing walls are 1' 6" thick at top, and built in steps, as shown in plan and section. The foundation of the abutments and piers to be 6 feet deep, built in 3 steps, with a 6-inch offset on each side at every step. The bridge to be protected from the force of the stream by the flooring of brick on edge 2 feet in thickness. The flooring to extend 10 feet to the front and 40 feet to the rear of the gates, and to be secured at both extremities by masonry walls, the front curtain wall being 2 feet thick at top, the foundation being 6 feet deep and 3 feet thick, while the rear curtain wall is 2 feet thick at top and 4 feet at bottom, the foundation being 10 feet deep. This wall is also supported by counterforts as shown in plan and section.

The regulating apparatus to consist of horizontal babool wales $14' \times 9" \times 9"$, and vertical teak baulks $15' \times 5" \times 5"$. Leakage below the gates to be prevented by a masonry sill 6 feet deep and 2 feet thick at top. The estimated cost of this amended design was Rs. 11,822.

Construction.

The whole of the masonry to be of the best burnt brick and lime.

Measurements.

In the abstract given below are stated the measurements of the work actually measured up and paid for, with cost of regulating apparatus, contingencies, &c :—

Quantities.	Description of Work performed.	Value of Work done.		
		Rs.	a.	p.
20,101.46 solid feet ..	Excavating foundation	145	4	9
13,810.00 " " ..	Filling in do. with burnt brick and lime..	4,414	1	4
14,670.00 " " ..	Superstructure do. do. do. ..	6,242	11	8
2,031.00 " " ..	Archwork do. do. do. ..	1,079	14	8
5,122.00 " " ..	Pavement do. do. (brick on edge)	1,710	9	6
26,114.97 " " ..	Filling in earth	197	4	8
75.92 " " ..	Cutstone	116	0	0
25 Number.	Babool wales	516	7	7
135 " ..	Teakwood baulks	1,939	3	2
	Contingencies	1,337	1	8
Total.....		17,698	11	0
Revised estimated amount....		11,822	0	0
Excess....Rs.		5,876	11	0

N.B.—Original estimate Rs. 8,539, excess over original Rs. 9,159-11.

MASONRY BRIDGE ON THE ROAD FROM MITTA KHAN-KA-TANDA TO SHAHDADPOOR, NOW CALLED 5TH MILE BRIDGE, MITROW CANAL.

GENERAL DESCRIPTION.

The description in the original is as follows, viz. the bridge to consist of 2 arches of 30 feet span, with a rise of 8 feet. The arches

to spring from a point 2 feet above water line, to allow of 8 feet headway for boats to pass under. A towing path, 5 feet wide, to be constructed under one of the arches, and to be paved with burnt bricks on edge set in lime. The whole of the masonry of the bridge to be constructed of the best burnt brick and lime.

The amount of work performed and the value of it are given below :—

Quantities.	Description of Work performed.	Value.		
		Rs.	a.	p.
	Excavating foundation	83	10	0
	Filling in foundation with burnt brick and lime ..	923	10	5
	Superstructure do. do. do.	2,243	1	0
	Archwork, burnt brick and lime	790	7	0
	Caps to cutwaters	18	0	0
	String course	43	8	0
	Parapet wall, including coping	293	8	0
	Centering and platform	1,216	0	0
	Roadway and approaches	432	1	4
	Towing path	106	11	2
	Contingencies	243	2	6
Total....		6,393	11	5
Estimated amount....		4,611	0	0
Excess over Estimate....Rs.		1,787	11	5

MASONRY BRIDGE ON THE ROAD FROM MEERPOOR TO KIPRA, NOW CALLED THE 30TH MILE BRIDGE, MITROW CANAL.

GENERAL DESCRIPTION.

The bridge to consist of an arch of 45 feet span. The arch to spring from a point 2 feet above water line, and to have a rise of 8 feet, so as to allow 10 feet headway for boats to pass, and a towing path, 5 feet wide, to be built under the arch, and paved with brick and lime on edge; the whole of the masonry to be of the best burnt brick and lime. The above is the description given in the original.

estimate, but the design has been entirely changed, and it has been converted into a regulating bridge, the design being as follows:— There are 5 arches, the centre one being 13 feet span and the remainder 5 feet span. Two land arches are also provided, 6 feet span, and under these towing paths are made. All the piers and the abutments are 3 feet thick, and all the arches spring at a height of 12' 6" from the canal bed. The rise of the centre arch and the 4 smaller ones (which latter are semi-circular) is 2½ feet, the thickness of the arching of the former being 1½ feet and of the latter 1 foot. The land arches are semi-circular, and arch 1 foot thick. Waterwings are provided, the up-stream are being curved, and the down straight and extending 20 feet below the abutment. They are 3' 3" thick at foundation, 9 feet high (above the canal bed), and 1 foot thick at top, the upper course being brick on edge. The foundation of the piers, abutments, and waterwings are 6 feet below the canal bed, built in steps of 1' 6" each, and the piers and abutments are 5 feet thick at bed of foundation. To prevent a scour under the bridge, a pavement of brick on edge 1' 6" thick is provided, while to prevent leakage, there is immediately under the gates a gate sill 2 feet thick at top and 2' 9" at foundation level, which is 6 feet below the bed of the canal; and as an additional security a front curtain wall 1' 6" thick at top and 2' 3" at foundation (which is on the same level as that of the gate sill) is built 6 feet in front of the gate sill, the intermediate space being paved 1' 6" thick with brick on edge; while this front curtain wall is still further strengthened by counterforts in the line of piers produced and joined to the piers. To support the pavement in rear, a curtain wall 1' 6" thick at top and 2' 3" at foundation (6 feet deep) is built, and the piers of the large arch are produced to meet this wall, and are built up with it to the level of the bed of the canal, thus acting as two counterforts. The regulating apparatus is as follows:—For the centre arch there will be a sliding frame, which, except when specially required, will not be let down the grooves, so that there may be free passage for boats. For the smaller arches teak gates 2 inches thick are provided, sliding against frictive rollers in grooves left for the purpose in the piers. They will be raised by means of a chain winding round a windlass to be fixed in stone-work in the pillars above. On the up-stream

side, instead of the usual parapet walls, a wooden railing will be fixed. Wing walls are provided as shown in plan, their foundation being 2 feet below the ground. The whole of the masonry has been constructed of burnt brick and lime.

In the following table are shown the amount of work already performed and the value of it as paid for:—

Quantities.	Description of Work performed.	Amount.		
		Rs.	a.	p.
17,183.63 solid feet....	Excavating foundation	505	10	8
10,243.42 " "....	Filling in do. with burnt brick and lime	2,401	10	7
11,182.86 " "....	Superstructure do. do. do. ..	2,667	7	10
1,462.67 " "....	Archwork do. do. do. ..	409	8	9
461.50 running, "....	String course	69	3	7
193.64 " "....	Coping	99	5	1
8 Number	Caps to cutwaters	24	0	0
26,000.00 solid feet....	Filling in roadway and approaches ..	105	9	2
	Contingencies	305	14	2
Total....		6,588	5	10
In the above items is not included the cost of woodwork for the regulating apparatus which will probably amount to		230	0	0
Probable Total....		6,818	5	10
Original estimate....		4,927	0	0
Probable excess over do. Rs.		1,891	5	10

BRIDGE ON THE MEERPOOR AND OOMERKOTE ROAD, NOW GENERALLY CALLED THE 44TH MILE BRIDGE, M. C.

GENERAL DESCRIPTION.

In the original estimate the description of this bridge is as follows:—"The bridge to consist of one arch of $37\frac{1}{2}$ feet span, with a rise of 8 feet. The arch to spring from a point 2 feet above water line to allow 10 feet headway for boats to pass. A towing path,

5 feet wide, to be constructed under the arch, and to be paved with burnt brick on edge set in lime." The cost was estimated at Rs. 3,675. The design of the Bridge has, however, since then been entirely changed, and it has been converted into a Regulating Bridge, to keep the water in the canal at a sufficient level to ensure a good supply for Atrah Wah (38th mile) and the kurriahs on both sides. The bridge now consists of three arches, the centre one 12 feet span and the other two 10 feet span each, with two small semicircular land arches 6 feet span each. The rise of the large arches is 2' 6", and thickness of arch ring 1' 6", the land arches being 1 foot thick, the piers are 3 feet thick, and the abutments 4 feet, while the abutments of the land arches are 2 feet thick. All the arches spring at a height of 13 feet above the pavement. The foundations of the piers and large abutments are 6 feet below the canal bed, and built in steps four of 1' 6" each with an offset of 3 inches on each side, so that at the foundation level the piers are 5 feet and the abutments 6 feet. The foundation of the up-stream water-wings are 3 feet deep, in two steps of 6" each, and 3' 6" wide. The foundations of the down-stream water-wings are also 3' 6" wide, but built as shown in plan. The up-stream water-wings are 8 feet high and 2 feet thick at top, and the down-stream 7 feet high and 1' 6" thick, the upper course of bricks in both cases being set on edge. The foundation of the abutments of the land arches is 2 feet below ground, and 3 feet thick, and the pathway under the arch is filled up to the level of the up-stream wing-walls (or nearly 2 feet) with broken bricks and earth well rammed. The foundation of the wing-walls is at the same depth as that of the abutments of the land arches. To prevent a scour under the bridge, a pavement or flooring of brick on edge 1' 6" thick is provided, extending from the front line of the piers to 6' 6" feet in rear of the (down-stream) cutwaters, while for a distance of 8' 3" immediately in rear of the front line of the piers, this pavement is 3 feet thick. This pavement is secured in rear by a curtain wall 1' 6" thick at top, and 2' 3" thick on the foundation level or 6 feet below canal bed. This curtain wall is strengthened by counterforts 3 feet long and 1' 6" thick at top. To prevent leakage from the front, a gate sill is provided 2 feet thick at top and 6 feet deep. The regulating apparatus consists of horizontal babool

walls 9" × 8" (four to each large span), with babool filling-in pieces between them; teak straining pieces 3 inches broad and let 6 inches into the wall, and vertical teak baulks 5 inches square. The parapet wall is 3 feet high, with a coping of 9 inches. The approaches have a longitudinal slope of 1 in 20, and side slopes of $1\frac{1}{2}$ to 1.

Construction.

The whole of the masonry to be of the best burnt brick and lime, the pavement and upper course of water-wings being set on edge.

Measurements.

Below are given the quantities of work done and cost, together with contingencies, &c. :—

Quantities.	Description of Work, and Rate.	Amount.
		Rs. a. p.
18,169.74 solid feet .	Excavating foundation, at Rs. 2 per 100 solid feet	363 6 3
6,202.09 " " "	Filling in do. with burnt brick and lime, at Rs. 22 per 100 solid feet ..	1,364 7 8
9,077.12 " " "	Superstructure do. do. at Rs. 22 per 100 solid feet	1,996 15 4
1,280.18 " " "	Archwork do. do. at Rs. 28 per 100 solid feet 353 7 2	
	Centering to the above .. 106 8 9	
		464 15 11
251.50 running " "	Coping at 8 as. per 100 running feet..	125 12 0
366.00 " " "	String course, at Rs. 15 per 100 running feet	54 14 4
83.83 square " "	Chunam plaster, at Rs. 10 per 100 square feet	8 6 5
8 Number.....	Caps to pillars, at Rs. 3 each	24 0 0
	Filling in roadway and approaches ..	431 0 2
	Woodwork for gates (regulating)	175 11 0
	Store room for the woodwork when not in use	149 2 0
	Contingencies	15 6 11
	Total....	5,174 2 0
	Original estimate....	3,675 0 0
	Excess over do. Rs.	1,499 2 0

BRIDGE OF 30 FEET WATERWAY ON THE SAMARA (AND GORCHANEE) ROAD, NOW CALLED THE 60TH MILE BRIDGE.

GENERAL DESCRIPTION.

For the original design the description is as follows, viz :—"The bridge to consist of one arch of 30 feet span, with a rise of 8 feet. The arch to spring from a point 2 feet above water line to give 10 feet headway for boats to pass under. A towing-path 5 feet wide to be constructed under the arch, and paved with burnt brick on edge and lime." The cost was estimated at Rs. 3,164. As above stated, this bridge is in the 60th mile of the canal, and is now under course of construction, but the original design has been entirely changed, and it is now being made into a Regulating Bridge, to ensure a more certain supply for the Samara Branch, of which a description will be given hereafter, and which takes off from the 57th mile of the canal. The present design is as follows :—The bridge consists of 2 arches of 10' 9" span each, the pier being 3 feet, and each of the abutments 4 feet thick. The arches have a rise of 2' 6", the arching being 1' 6" thick, and spring at 9' 6" above the bed of the canal, or 3' 6" above the ordinary water line. The foundations of the pier and abutments in this bridge are similar, and at the same depth, as those of the piers and large abutments in the preceding bridge (44th mile), and the up and down-stream water-wings are precisely similar from the foundation up to the top course. The foundations of the wing-walls are on the level of the bed of the canal, i. e. about 6' 6" below the ground line. They are here 3' 3" wide, and the wing-walls are built in steps, as shown in the drawing of this bridge. The parapet wall is 1' 6" high, with a crossing of 9 inches. The approaches have side slopes of $1\frac{1}{2}$ to 1, and a longitudinal one of 1 in 20. The regulating apparatus, and the arrangement of the gate sill, rear curtain wall, and pavement, is exactly similar to that described for the preceding bridge.

Construction.

The whole of the masonry to be of the best burnt brick and lime, the pavement and upper course of water-wings being set on edge.

Measurements.

Below are given the quantities of work done and the cost, together with contingencies, &c. :—

Quantities.	Description of Work performed, and Rate given.	Amount.
		<i>Rs. a. p.</i>
11,887·86 solid feet....	Excavating foundation, at Rs. 2 per 100 solid feet	237 8 10
5,899·55 " "	Filling in do. with burnt brick and lime, at Rs. 22 per 100 solid feet ..	1,297 14 4
2,990·61 " "	Superstructure do. do. at Rs. 22 per 100 solid feet	657 14 4
	Centering for archwork	37 4 0
	Total amount of work already performed	2,230 9 9
	Probable amount which will be required to complete	1,700 0 0
	Probable total cost of bridge when complete	3,930 9 9
	Original estimate....	3,164 0 0
	Probable excess over do....Rs.	766 9 9

WEIR ACROSS THE DOWUD BRANCH OF THE NARRA RIVER FROM BAKHORA TO SAHPOO-KA-KUA, NOW CALLED THE MUKKEE WEIR.

In the original estimate the description is given as follows, viz :—
 “ The weir to be constructed according to the sections. The whole of the masonry to be of the best burnt brick and lime, and the up-stream side to be plastered with chunam to prevent leakage. The earth excavated from the foundation to be used in making a long front slope to the weir for the same purpose. An opening, 15 feet in width, to be left for the passage of boats. The opening to be fitted

with sleepers for closing it during the low season." The value of the work performed is shown in the table below :—

Quantities.	Description of Work performed.	Value.
		Rs. a. p.
	Excavating foundation	2,250 11 11
	Filling in do. with burnt brick and lime	26,794 6 4
	Superstructure do. do. do.	16,849 13 3
	Filling in dry brickwork in rear	95 6 0
	Front slope.....	166 8 8
	Contingencies	689 14 4
	Do. temporary bund near Saheoo-ka-kua	417 12 1
	Total....	47,264 8 7
	Original estimate....	43,944 0 0
	Probable excess over do....Rs.	3,320 8 7

EXCAVATING CANAL.

The amount shown under this head as already spent is made up as follows :—

		Rs. a. p.
84,045,572 solid feet..	Excavation, including ramming and levelling	2,36,300 6 8
	Clearing jungle and making out- line	1,305 3 6
	Tools and plant; that is powrahs, baskets, &c.	10,472 0 6
	Extra establishment	12,925 7 5
	Contingencies connected with the excavation	9,458 4 4
	Total....Rs.	2,70,461 6 5

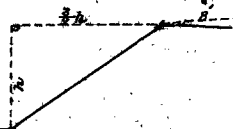
N.B.—In the item "Excavation," 19,316,198·48 solid feet are on account of clearing silt, repairing breaches, &c. year by year, and the remainder, 64,729,373·52 solid feet, for excavation proper.

MASONRY HEADS TO DISTRIBUTING BRANCHES.

In the original estimate no design for these was submitted, as it stated that the dimensions and cost of these works will be fixed after the opening of the canal. They were roughly calculated to cost Rs. 150 each, but according to the present standard plan of these heads, this sum does not nearly suffice.

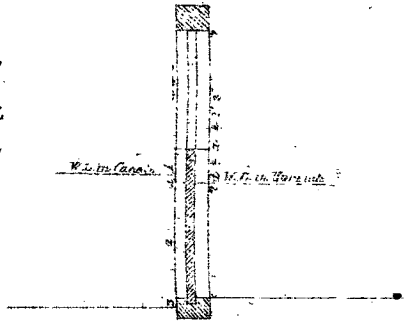
GENERAL DESCRIPTION.

The heads to be constructed, according to the standard plan, of the best burnt brick and lime masonry. In any head if b = bottom breadth, d = depth of water, then b shall be made = $2d$ when practicable. To ensure a steady supply there shall be in all cases a difference between the water line in the canal and that in the Kurriah, this difference being never less than 3 inches. The arch to spring from the water line in Kurriah, or at a height = d above the sill. The thickness of the arch to be 6 inches up to 4 feet, above that 1 foot; the rise to be one-sixth of the span. The abutments to be one-third of the span, but never less than 1' 6" thick. They have an offset on each side at the foot of 3 inches, giving a foundation of 2 feet thick; the bed of foundations to be fixed at 2 feet below the gate sill. The arched channel to be 25 feet long, its face to be fixed at a distance of 8 feet from the canal bank, i.e. at $\frac{3}{4}d + 8$ feet from the foot of the slope of the bank, h being equal to the depth of water in the canal. The width of the roadway will vary according to the height of the crest of the arch of the Kurriah. The level of it to be fixed at 3 feet above the water line in canal where it is above ground, and 3 feet above ground when the level of the latter is above that of the water. The up-stream water-wings to be built up to 1 foot above ordinary water line where that is above ground line, or up to the latter where it is below. They are to be 1' 6" thick, and when the height exceeds $4\frac{1}{2}$ feet, to be made of that thickness (1' 6") at top, with a batter in rear of 3 feet in height. There is to be a step of 3 inches on each side at foundation, the bed of which latter is on the same level as those of the abutment. The open channel between the wing-walls and the arched channel to be paved with brick on edge 1' 6" thick.

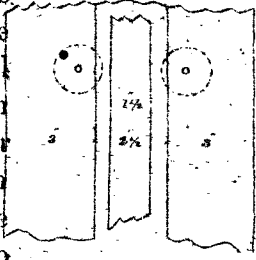


A wall 3 feet thick and 3 feet deep to be built under the gate sill, and front and rear curtain walls 1' 6" thick, and carried down to 3 feet below the level of the sill to be built. The gates are to be of pukka teak from $1\frac{1}{2}$ to $2\frac{1}{4}$ inches thick, their height being equal to $d+1$ foot + a above the sill, or one foot above the canal water line; the total height of gate will be 3 inches more than this, it being let thus much into the sill.

The under side of the cap of the frame to be fixed at a height $= 2d + 1' 3'' + a$ above the sill; so that the extreme height to which the gate may be opened will be equal to d . The gate frame to be of babool well seasoned, and scantling 8 to 9 inches square. The



sides have a groove $2\frac{1}{2}$ inches broad and $2\frac{1}{2}$ inches deep, cut into them, in which the gate works against friction wheels projecting $\frac{1}{4}$ inch beyond the faces of the grooves. The gates will be opened by a small windlass fixed on the cap. Tampering with these will be prevented by putting a stopper on the chain below the cap and securing it with a padlock, the key of which will be kept by the Canal authorities. Three gauges to be fixed to each head—one showing the height of water above the gate; one (cut on the frame itself) showing the height to which the gate is opened; the other showing the depth of water in the Kurriah.



SPECIAL CASES.

1. *Kurriahs on the Western or Right Bank.*—These have the wall under the sill carried down to 2 feet below the canal upon a level with which the pavement is fixed. The thickness of the latter is $1\frac{1}{2}$ feet as before, except for a length immediately in front of the sill wall equivalent to $1\frac{1}{2}$ times the height of the latter where it is 2 feet.



2. *Heads showing two Branches.*—The open channel is perpendicular to the direction of the canal, the axes of the branches being fixed at an angle of 15° with it. The breadth of the roadway varies according to the height of the crown of the arch; the length of which is 25 feet as before. When the sills of both branches are not on one level, the pavement of the open channel should be on a level with the lower one. For a length of 6 feet also in rear of the gates the foundations of both branches should be on the same level, being regulated by the lower one.



3. *Heads with three Branches.*—An example of these is given in the drawing, with full directions also for setting it out. The same rule regarding depth of foundations applies in this case as in No. 2. The width of the road is there fixed at 12 feet, the length of channels being regulated by it, so that the foot of the exterior slope falls within the angle of the rear face of the arched channel.

Remarks.—All the Kurriah heads are necessarily not of the same size, but yet it will suffice for the purposes of this estimate to calculate for one specified head (to be taken as the mean) 4 feet wide, with 2 feet depth of water, the ground line being supposed to be 6 inches above the water line, and 6 feet depth of water in canal, and to commence with—

SINGLE HEAD—EAST BANK.

MEASUREMENTS.	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Removing earth to level of top of sill	1	$\frac{8+12\cdot875}{2}$	7.5	3.25	254.414	
Do. do. pavement of arched channel	1	25.00	7.5	3.00	562.500	
Front curtain wall	1	7.50	1.5	2.75	30.937	
Gate sill wall	1	3.50	3.0	2.875	30.187	
Abutments	2	22.00	2.0	2.25	198.000	
Rear curtain wall	1	3.50	1.5	3.00	15.750	
Pavement arched channel..	1	22.00	3.5	1.50	115.500	
Do. open do. . .	1	8.50	3.5	1.25	37.187	
Water-wings up-stream...	2	8.50	1.5	2.00	51.000	
Do. down do.	2	3.00	1.5	2.25	20.250	
Total solid feet excavating foundation....						1,315.726

*Filling in Foundation with
Burnt Brick and Lime.*

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Front curtain wall	1	7.5	1.5	2.75	30.937	
Gate sill wall	1	3.5	3.0	2.875	30.187	
Abutments	2	22.0	2.0	2.25	198.000	
Water-wings up-stream....	2	8.5	2.0	2.00	51.000	
Do. down do.	2	3.0	1.5	2.25	20.250	
Rear curtain wall	1	3.5	1.5	3.00	15.750	
Pavement arched channel..	1	22.0	3.5	1.50	115.500	
Do. open do. ..	1	8.5	3.5	1.25	37.187	
Total solid feet filling-in foundation with burnt brick and lime..						498.811

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	25.0	1.5	2	150.000	
Skew backs	2	1.25	25.0	0.5	31.250	
area						
Arching	1	25.0	2.50		62.500	
Backing	2	25.0	1.875		93.750	
Up-stream water-wings....	2	$\frac{8+12.875}{2}$	1.5	3.25	101.765	
Down do. do.	2	1.5	1.5	3.0	13.500	
Parapet wall to retain earth (roadway)	2	7.0	1.0	1.0	14.000	
Total solid feet superstructure of burnt brick and lime..						496.765

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Gate	1	4.375	3.75	0.16	2.734	
Guages 4" x 2"; one 3 feet long, the other 3' 3"	1	6.25	0.33	0.16	0.347	
Total solid feet teakwood..						3.081

Babool Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Top and bottom pieces of frame	2	7'0	0'75	0'75	7'875	
Side pieces do.....	2	7'25	0'75	0'75	8'156	
Windlass	1	1'50	0'75	0'75	0'844	
Do. side pieces	2	1'50	0'75	0'75	1'688	
Total solid feet babool wood..						18'563

Ironwork.

Weight in lbs.

Steps to windlass (2) 3' 6" × 2" × ½"	11'00
Do. do. (2) 2' 0" × 2" × ½"	4'00
Do. to gate (1) 9' 6" × 2" × ½"	16'00
Chain (1) 1½ inches, links ½ inch thick, 3' 6" long	4'25
Bolts, ½ inch, with nuts, 2' 9" long.....	1'50
3-inch nails 18	2'50
Total weight (in lbs.) of ironwork..	39'25

Earthwork.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Roadway over bridge	1	Area 18'5	7'0	3'0	388'500	
Total solid feet earthwork..						388'500

Quantities.	Description of Work, and Rate.	Amount.
1,315·725 solid feet	Excavating foundation, at 12 annas per 100 solid feet	Rs. a. p. 9 13 11
498·061 " " "	Filling in do. with burnt brick and lime, at Rs. 27 per 100 solid feet	134 11 11
496·765 " " "	Superstructure do. do. at Rs. 27 per do.	134 2 0
3·081 " " "	Teak wood, at Rs. 4-4-10 per solid foot..	13 1 6
18·563 " " "	Babool wood, including dammering, at Rs. 2 per solid foot	37 2 0
39·25 lbs.	Ironwork, at Rs. 10 per maund of 80 lbs.	4 15 1
388·500 solid feet..	Earthwork, at Rs. 3-8-0 per 1,000 solid feet	1 5 9
	Total....	335 4 2
	Add contingencies at 5 per cent....	16 12 2
	Grand total.... Rs.	352 0 4

KURRIAH HEAD, WESTERN BANK.

On the western bank, where the ground slopes towards the canal, the Kurriah Heads are intended to act as inlets to let the rainwater into the canal. The only difference in the design is, that the pavement in the open channel is on the level of the bed of the canal, and the foundation of the front curtain wall and gate sill is also below the bed of the canal.

<i>Excavating Foundation.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Removing earth to level of bed of canal	1	13·25	7·5	6·5	645·9375	
Do. do. pavement of arched channel	1	25·00	7·5	3·0	562·5000	
Front curtain wall	1	7·50	1·5	2·5	28·1250	
Gate sill wall	1	3·50	3·0	2·5	26·2500	
Abutments	2	22·00	2·0	2·25	193·0000	
Waterwings up-stream	2	15·50	2·0	2·00	124·0000	
Do. down-stream	2	3·00	1·5	2·25	20·2509	
Rear curtain wall	1	3·5	1·5	2·50	13·125	
Pavement in open channel (portion)	1	9·75	3·5	2·50	85·3125	
Do. do. do. do.	1	4·25	3·5	1·50	22·3125	
Do. arched channel	1	22·00	3·5	1·5	115·5000	
Total solid feet excavating foundation....						1,841·312

<i>Filling in Foundation with Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Front curtain wall.....	1	7.5	1.5	2.5	23.125	
Gate sill wall.....	1	3.5	3.0	2.5	26.250	
Abutments.....	2	22.0	2.0	2.25	198.000	
Waterwings up-stream.....	2	15.50	2.0	2.00	124.000	
Do. down-stream....	2	3.00	1.5	2.25	20.250	
Rear curtain wall.....	1	3.5	1.5	2.50	13.125	
Pavement in open channel (portion).....	1	9.75	3.5	2.50	85.3125	
Do. do. do. do..	1	4.25	3.5	1.50	22.3125	
Do. arched channel.....	1	22.0	3.5	1.5	115.5000	
Total solid feet filling in foundation....						635.875

<i>Superstructure Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments.....	2	25.0	1.5	2.0	150.00	
Skew backs.....	2	25.0	1.25	0.5	31.25	
Arching.....	1	25.0	Area 2.50		62.50	
Backing.....	2	25.0	1.875		93.75	
Up-stream waterwings.....	2	13.25	1.25	6.5	215.312	
Down-stream do.	2	1.5	1.5	3.0	13.500	
Parapet wall to retain earth of roadway.....	2	7.0	1.0	1.0	14.000	
Total solid feet superstructure burnt brick and lime....						580.312

The remaining items, viz. teak wood, babool wood, ironwork, and earthwork, are the same as those for a kurriah head on the east bank.

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.
1,841·312 solid feet..	Excavating foundation, at 12 annas per 100 solid feet	Rs. a. p. 13 12 11
635·875 " " ..	Filling in do. at Rs. 27 per do.	171 11 0
590·312 " " ..	Superstructure, at Rs. 27 per do.	156 10 11
3·081 " " ..	Teak wood, at Rs. 4·4 per solid foot	13 1 6
18·563 " " ..	Babool wood, at Rs. 2 per do.	37 2 0
39·25 lbs.	Ironwork, at Rs. 10 per maund of 80 lbs. ...	4 15 1
338·500 solid feet..	Earthwork, at Rs. 3·8 per 1,000 solid feet..	1 5 9
	Total....	398 11 2
	Add contingencies at 5 per cent.	19 15 0
	Grand total....Rs.	418 10 2

When the canal is complete, there will probably be 120 single heads to the kurriahs distributed as follows:—East bank 72, West bank 48; and the cost will be as below, viz:—

	Rs. a. p.
72 kurriah heads, East bank, at Rs. 352-0-4 each	25,345 8 0
48 do. do. West bank, at Rs. 418-10-2 each	20,094 8 0
Total....Rs.	46,440 0 0

Besides these single heads, five double ones and one triple one have been constructed, the cost of which is shown below:—

	Amount.	Total.
	Rs. a. p.	Rs. a. p.
Double head 21st mile East bank.....	589 14 9	
Do. do. 23rd do. do.	623 13 2	
Do. do. 24th do. do.	603 11 2	
Do. do. 22nd do. West bank	629 15 4	
Do. do. 24th do. do.	873 10 8	3,326 1 1
Triple head 24th do. East bank	986 10 3	986 10 3
Total....		4,312 11 4
Add probable cost of single heads....		46,440 0 0
Probable cost of masonry heads—Total....Rs.		50,752 11 4

MODULES FOR SELLING WATER.

These were roughly estimated for in the original without any design. If found necessary hereafter, a detailed estimate can be submitted.

LOCK INTO SILHOO WAH.

This work will not now be required, as from the change of direction towards the tail, the canal will not pass over or cross the Silhoo Wah.

TWO BRIDGES ON THE ROAD FROM JOODA TO NUBEESIR.

These two bridges will not now be required, as this road can be diverted to cross over a bridge proposed to be built in the 85th mile.

ESCAPE IN THE 65TH MILE.

In the original design this escape was to have been constructed in the 62nd mile, but as there has been a slight change in the direction of the canal, it will now be in the 66th mile, near the Dhora at Karora. It is to consist of a waterway of 10 feet span, with a pavement flooring on the level of the bed of the canal, so as to admit of the escape of the water at its lowest level. This waterway will be carried right through the spoil bank (East side), and a channel about 1,000 feet long, 10 feet wide at bottom, and side slopes of $1\frac{1}{2}$ to 1, and of an average depth of 4 feet, will have to be excavated to run the water off, when necessary, into the above Dhora. The spoil bank is 13·20 feet wide at top, 25·20 wide at bottom, and 4 feet high, the side slopes being $1\frac{1}{2}$ to 1. In excavating the foundation this will have to be removed for the whole length of the bridge. The depth of excavation of canal at this point is 6·64 feet; and the arch will spring from the ground line;—that is, the abutments will be 6·64 feet high. They are 5' 6" thick at foundation and 3' 6" at superstructure. Up and down-stream water-wings are provided, the up-stream ones being carried forward as far as the

foot of the side slope of the canal, and being built up with a slope of $1\frac{1}{2}$ to 1, while the down-stream ones are built square up to the level of the ground. The water-wings are 1' 6" thick at top and 3' 3" thick at foundation. The foundations of the abutments and water-wing are 6 feet below the bed of the canal, built in four steps of 1' 6" each. Straight wing-walls are provided terminating in newels $2' \times 1' 6"$. The foundations of the wing-walls are 3 feet below the ground line and are 2' 3" thick. The waterway is 20 feet wide between the parapet walls which latter are 2 feet thick. The rise of arch is 2 feet and thickness 1 foot. To prevent a scour under the bridge, a pavement of brick on edge is provided, extending from the foot of the up-stream water-wings to 8 feet in rear of the down-stream parapet walls. The whole of this pavement is 1' 6" thick, except the portion, 9.40 feet long, immediately in rear of the gate sill, which is 3 feet thick. The gate sill wall is 2 feet thick at top and 2' 9" at bottom, and the rear curtain wall 1' 6" at top and 2' 3" at bottom. The foundations of both these walls are 6 feet deep, built in four steps of 1' 6" each. The regulating apparatus will be similar to, but on a larger scale than, that employed on the masonry kurriah heads.

Construction.

The whole of the masonry to be of the best burnt brick and lime.

Measurements.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Removing spoil banks for whole length of bridge ..	1	55.0	Mean 19.20	4.0	4,224.000	
Abutments	2	24.0	5.5	12.64	3,336.960	
Up-stream waterwings re- turn portion.....	2	4.60	3.25	12.64	377.936	
Do. do. curved do. ..	2	15.00	3.25	9.96	971.100	
Do. do. return do. ..	2	1.75	1.25	6.0	26.250	
Down-stream waterwings ..	2	15.00	3.25	12.64	1,232.400	
Return to do.	2	1.75	1.25	12.64	55.300	
<i>Removing earth to level of bed of Canal.</i>						
Between up-stream water- wings curved portion	1	9.96	mean 14.5	6.64	953.9488	
Abutments, including up- stream waterwings, straight portion	2	23.60	8.0	6.64	3,033.4640	
Between down-stream water- wings	1	8.0	mean 19.0	6.64	1,009.2800	
<i>Pavement.</i>						
Between up-stream water- wings curved portion	1	9.96	14.5	1.5	216.6300	
In front of gate sill.....	1	4.60	8.0	1.5	55.2000	
Gate sill	1	8.00	2.75	6.0	132.0000	
To end of abutments	1	21.25	8.00	1.5	255.0000	
Portion 3 feet thick in rear of gate sill	1	8.65	8.00	1.5	103.8000	
From end of abutments to rear curtain wall	1	5.75	mean 9.5	1.5	81.9375	
Rear curtain wall	1	12.50	2.25	6.0	168.7500	
Wing walls	4	14.00	2.25	3.0	378.0000	
Newels to do.	4	2.00	2.75	3.0	66.0000	
Total solid feet excavating foundation....						16,687.9563

<i>Filling in Foundation with Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	24	4.75	6	1,368.0000	
Wingwalls	4	15	2.125	3	382.5000	
Newels.....	4	2	2.625	3	63.0000	
Up stream waterwings, straight portion	2	4.60	2.875	6	158.7000	
Do. do. do. curved do. ..	2	15.00	2.875	6	517.5000	
Do. do. do. returns	2	2.5	1.25	6	37.5000	
Down do. do.....	2	15.00	2.875	6	517.5000	
Returns to do.....	2	2.50	1.25	6	37.5000	
Pavement between up-stream waterwing	1	9.96	mean 17.75	1.5	265.1850	
Do. in front of gate sill ..	1	4.60	9.5	1.5	65.5500	
Gate sill	1	8.75	2.375	6.0	124.6875	
To end of abutments	1	22.00	9.5	1.5	312.5000	
Portion 3 feet thick in rear of gate sill	1	9.15	9.0	1.5	123.5250	
From end of abutments to rear curtain wall	1	6.5	mean 11.5	1.5	112.1250	
Rear curtain wall	1	13.00	1.875	6.0	146.2500	
Total solid feet filling in foundation with burnt brick and lime..						4,233.0225

<i>Superstructure, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	24	3.5	6.64	1,115.52	
Skew backs.....	2	3.125	24.0	0.75	112.50	
Backing	2	24.0	area 5.00		240.00	
Spandul walls	4	1.5	area 6.375		38.25	
Up stream waterwing, straight portion	2	4.6	1.75	6.64	106.904	
Do. do. do. curved do. ..	2	15.0	1.75	3.32	174.300	
Down do. do.	2	15.0	1.75	6.64	348.600	
Returns to do.....	4	2.5	1.25	6.64	83.000	
Wingwalls	4	15.00	1.625	3.00	292.500	
Newels.....	4	2.00	2.125	3.00	51.000	
Face walls	2	47.00	1.25	1.00	117.500	
Newels.....	4	2.00	2.25	1.00	18.000	
Parapet walls.....	2	47.00	1.00	1.5	141.000	
Newels.....	4	2.00	2.00	1.5	24.000	
Total solid feet superstructure, burnt brick and lime....						2,863.074

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Archwork, Burnt Brick and Lime.</i>						
Arch	1	11.802	24	1.0	273.248	
Total solid feet archwork, burnt brick and lime ..						273.248

	Number.	Length.	Running Feet.
<i>String-course.</i>			
To face walls, including newels.....	2	52.50	105.00
Total running feet string-course			105.00

	Number.	Length.	Running Feet.
<i>Coping.</i>			
Parapet walls, including newels.....	2	51.00	102.00
Total running feet coping....			102.00

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Earthwork.</i>						
Filling in between spandrel wall	2	19.00	Area 6.375		242.250	
Do. do. wing-walls ..	2	17.00	19.25	4.0	2618.000	
Roadway over bridge	1	17.00	19.5	1.0	331.500	
Total solid feet earthwork....						3,191.750

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Baboolwood.</i>						
Frames, top and sill.....	2	13-0	0-75	0-75	14-625	
Do. side pieces	2	11-5	0-75	0-75	12-9375	
Windlasses	4	1-5	0-75	0-75	3-3750	
Bit heads	4	1-5	0-75	0-75	3-3750	
Total solid feet baboolwood....						34-3125

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Teakwood.</i>						
Gates.....	2	1-0	7-0	0-25	17-50	
Guage	1	6-64	0-33	0-16	3-688	
Total solid feet teakwood....						21-188

	Weight in lbs.
<i>Ironwork.</i>	
Straps to gates	50-000
Do. windlasses and bithead	65-000
4 chains 4' 6"	25-000
Bolts	4-500
3 inch nails	5-000
Total weight in lbs. ironwork....	149-50

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Escape Channel Excavation.</i>						
Channel 10 feet at bottom, average depth 4 feet, side slopes 1½ to 1, 1,000 feet long	1	1000	16-0	4	64,000-00	
Total solid feet excavation, Escape Channel....						64,000-00

ABSTRACT.

Quantities or Numbers.	Description of Work, and Rate.	Amount.
		Rs. a. p.
16,687-9563 solid feet..	Excavating foundation, at Rs. 0-12-0 per 100 solid feet.....	125 2 7
4,233-0225 do. ..	Filling in do. burnt brick and lime, at Rs. 23 per do.	973 9 6
2,863-0740 do. ..	Superstructure do. do. at Rs. 25 per do.	715 12 4
273-248 do. ..	Archwork do. do. at Rs. 32 per do. ..	88 12 11
105-00 rung. feet ..	String course, at Rs. 15 per 100 running feet	15 12 0
102-00 do. ..	Coping at Rs. 0-8-0 per running foot..	51 0 0
3,191-750 solid feet..	Earthwork at Rs. 3-8-0 per 1,000 solid feet	11 2 9
34-3125 do. ..	Baboolwood, at Rs. 1-8-0 per solid foot.	51 7 0
21-188 do. ..	Teakwood, at Rs. 4-4-0 per solid foot..	90 0 9
149-50 lbs.	Ironwork, at Rs. 10 per maund of 80 lbs.	18 11 0
64,000-00 solid feet..	Excavation in escape channel at Rupees 3-4 per 1,000 solid feet	208 0 0
Total....Rs.		2,349 7 4
Add—Contingencies at 5 per cent....		117 7 7
Grand Total....		2,466 14 11

RECAPITULATION

Of Works enumerated in the Original Estimate, and which have been, or will be, carried out.

	Rs. a. p.
Excavating of main canal	3,38,194 4 11
Jullub bund	10,753 12 5
Weir across Oowud or Mukkee	47,264 8 7
Regulating bridge at head of canal (bukham)	17,264 11 0
Masonry bridge on road from Mitta Khan-ka-Tanda to Shadapore or 5th mile bridge.....	6,398 13 4
Do. do. Meerpoor and Kipra road or 30th mile bridge.	6,818 5 10
Do. do. Meerpoor and Oomerkote road or 44th do. ..	5,174 2 0
Do. do. Samara and Garchanee road or 60th do.	3,930 9 9
Escape at Karora (or in the 66th mile	2,466 14 11
Masonry heads to Kurriahs	50,752 11 4
Total....Rs.	4,84,452 14 1

ADDITIONAL WORKS NOT ESTIMATED FOR IN THE ORIGINAL ESTIMATE FOR THE MITROW CANAL.

MASONRY AND TIMBER (combined) ROAD BRIDGES.

General Description.

The masonry bridges originally designed being only four in number as far as the 60th mile, excluding the Regulating Bridge at head of the canal, were quite insufficient to accommodate the traffic across the canal. Accordingly a general design was submitted for additional timber bridges (with masonry abutments), and bridges according to this design have already been built in the following miles, viz. 9th, 12th, 14th, 18th, 21st, 24th, 27th, 33rd, 37th, 40th, 48th, 52nd, 57th, and 65th. The design is as follows:—When the water line is below the ground. The abutment is 13 feet long, 2' 6" thick at foundation, which is 2 feet below the ground, 2 feet thick at ground line, and 1' 6" thick at top, and is counter-sloping it being 6' 6" high up to the flooring of the roadway. The wing-walls are at right angles to the abutment, and 7 feet long, measuring from the face of the abutment. Their foundation is on the same level as that of the abutment, and also 2 feet thick; on the ground line they are 1' 6" thick, and built up vertical to the same height as the abutment. A towing-path 5 feet wide is provided in front of the abutment, and is supported by a retaining wall. The foundation of this wall is 3 feet below the bed of the canal, and is there 3' 6" wide, diminishing by 3 inches each step, of 1 foot each up to bed of canal. Here the wall is 2' 6" thick, and is carried up to a height of 8 feet, the thickness diminishing by 4 steps in rear up to the top, where it is 1' 6" thick. In connection with this retaining wall are water-wings of the same section as it, and built up to the same height. When the water line is above the ground. The foundation of the abutment is 3 feet below the bed of the canal and 6 feet thick. At bed of the canal the abutment is 5' 6" thick, and is built up with steps in rear to a height of $14\frac{1}{2}$ feet and is 1' 6" thick at top. Waterways are provided, the foundation being at the same depth as that of the abutment, and 3' 6" thick. These walls are carried up to a height of 8 feet, and are 1' 6" thick at top. Openings are left in the abutments to receive the ends of struts and beams to support the towing

path, which in this case is made for wooden framework with rafters, mats, and earth.

The timber portion of the design is always the same, and there are 4, 3, or 2 spans, according to the width of the canal, at the different sites of these bridges. There are wooden trestles of baboolwood which support babool beams; across these beams are laid deodar baulks 4" × 5", 3 feet apart, sometimes less, from centre to centre. Over these baulks are laid kirrul rafters tolerably close to each other, and above these rafters, mats, and then the earth for the roadway, which in some bridges is retained by deodar planks running the whole length of the bridge; in others by kucha bricks built up to one foot in height. For the safety of the traffic each bridge has a wooden railing. This railing is 3 feet in height up to the top of the top rail. It consists of upright posts 4" × 4" fixed into the baulks mentioned above, and of the middle and top rail each 4" × 5", while to strengthen the railing there are struts 3" × 2" at every other upright post. All the woodwork of the railing is of deodar wood. The tressels are fixed at a depth of 4 feet below the bed of the canal, and the whole woodwork of the bridge is well dammered. Over each tressel long iron screws with nuts fasten the baulk and beam securely to the top sill of the tressel. The surface of the roadway (1 foot thick) is 15' 6" above the bed of the canal. The value of the work performed on the bridges enumerated above is given at follows, viz:—

9TH MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation.....	15 7 0
Filling in foundation with burnt brick and lime.....	37 12 2
Superstructure do. do.	437 8 5
Tressels of corbels	439 1 8
Timber work superstructure	217 4 7
Railing	136 12 11
Dammering	56 14 2
Roadway and approaches	67 1 1
Contingencies	67 4 8
Grand Total....Rs.	1,475 2 8

12TH MILE BRIDGE M. C.

Description of Work performed.	Value.		
	Rs.	a.	p.
Excavating foundation.....	16	0	0
Filling in foundation with burnt brick and lime	111	7	2
Superstructure	482	3	11
Tressels to corbels	355	10	6
Superstructure, timber work	188	3	5
Railing	159	0	10
Dammering	49	13	2
Roadway	77	1	0
Chunam pointing	7	10	0
Contingencies	40	9	2
Total....Rs.	1,481	11	2

14TH MILE BRIDGE M. C.

Description of Work performed.	Value.		
	Rs.	a.	p.
Excavating foundation.....	15	0	0
Filling in foundation with burnt brick and lime	59	2	6
Superstructure	585	15	1
Tressels and corbels.....	381	10	9
Timber superstructure	203	13	0
Dammering	43	3	2
Chunam pointing.....	5	4	0
Filling in roadway and approaches	100	14	2
Railing	170	10	7
Contingencies	51	11	7
Total....Rs.	1,571	4	10

18TH MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	15 8 0
Filling in do.	70 18 7
Superstructure	506 11 7
Tressels and corbels	329 11 0
Timber superstructure, including railing	258 7 3
Dammering	27 15 2
Chunam pointing	8 8 3
Filling in roadway and approaches	92 8 7
Contingencies	26 3 10
Total....Rs.	1,335 7 3

21st MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	15 8 0
Filling in do.	35 8 0
Superstructure	534 15 7
Tressels and corbels	347 12 11
Timber superstructure, including railing	346 0 3
Filling in roadway and approaches	84 11 0
Pointing (chunam)	3 12 0
Contingencies	45 15 4
Total....Rs.	1,414 3 10

24TH MILE BRIDGE M. C.

Description of Work performed.	Value.		
	Rs.	a.	p.
Excavating foundation	15	3	3
Filling in do.	60	8	8
Superstructure	593	7	2
Tressels and corbels	325	11	5
Timber superstructure, including railing	205	15	7
Dammering	49	3	2
Chunam pointing	9	4	0
Filling in roadway and approaches	74	15	9
Contingencies	46	3	6
Total....Rs.	1,380	8	8

27TH MILE BRIDGE M. C.

Description of Work performed.	Value.		
	Rs.	a.	p.
Excavating foundation	14	5	8
Filling in do.	132	7	2
Superstructure	393	13	10
Tressels and corbels	313	1	5
Timber superstructure, including railing	213	11	0
Dammering	59	11	5
Filling in roadway and approaches	93	2	11
Chunam pointing	7	4	1
Contingencies	48	15	8
Total....Rs.	1,276	13	2

33RD MILE BRIDGE, M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	18 3 0
Filling in foundation	105 10 6
Superstructure	324 0 10
Tressels and corbels	298 3 9
Timber superstructure, including railing	328 10 11
Dammering	57 10 6
Chunam pointing	7 12 2
Roadway and approaches	80 13 9
Contingencies	58 11 10
Total....Rupees.	1,279 13 3

37TH MILE BRIDGE, M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	12 6 0
Filling in foundation	99 10 8
Superstructure	377 9 2
Timber superstructure, including railing	290 11 3
Tressels and corbels	270 8 2
Approaches and roadway	116 14 7
Chunam pointing	4 1 11
Dammering	26 14 7
Contingencies	62 3 10
Total....Rupees.	1,255 0 2

40TH MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	12 9 0
Filling in foundation with burnt brick and lime	76 14 8
Superstructure	656 2 2
Tressels and corbels	282 2 10
Timber superstructure, including railing	297 14 8
Dammering	39 10 2
Filling in roadway and approaches	58 5 0
Chunam pointing	5 7 4
Contingencies	35 13 0
Total.... Rupees.	1,464 14 10

48TH MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	14 7 2
Filling in foundation with burnt brick and lime	121 10 10
Superstructure	448 12 10
Tressels and corbels	219 10 2
Timber work superstructure	58 13 5
Dammering	34 7 7
Filling in roadway	9 8 3
Chunam pointing	1 15 6
Railing	161 11 9
Contingencies	37 7 0
Total.... Rupees.	1,108 8 6

52ND MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	14 7 2
Filling in do. with burnt brick and lime	128 10 10
Superstructure	412 15 0
Tressels and corbels	125 6 8
Timber superstructure, including railing	267 10 10
Dammering	31 14 4
Filling in roadway and approaches	50 4 6
Chunam pointing	6 3 7
Contingencies	39 10 9
Total Rupees....	1,077 3 8

57TH MILE BRIDGE M. C.

Description of Work performed.	Value.
	Rs. a. p.
Excavating foundation	8 3 3
Filling in do.	125 9 9
Superstructure	442 2 9
Tressels and corbels	43 10 0
Timber superstructure, including railing	312 8 2
Dammering	29 5 0
Filling in roadway and approaches	54 14 11
Chunam pointing	5 1 7
Contingencies	34 8 5
Total Rupees....	1,055 15 10

65TH MILE BRIDGE M. C.

Description of Work performed.	Value.		
	Rs.	a.	p.
Excavating foundation	13	1	7
Filling in do.	35	6	10
Superstructure	227	15	8
Tressels and corbels.....	32	15	0
Timber superstructure, including railing	389	14	0
Dammering	29	5	0
Filling in roadway and approaches	26	0	4
Chuman pointing	5	14	7
Contingencies	17	2	6
Total Rupees	777	11	6

68TH MILE BRIDGE M. C.

General Description.

This bridge is to be built in the 8th furlong of this mile, and to be of masonry and timber combined, of the same description as the road bridges already built on the canal, and which have been described before. The bed of canal is here 6' 9" below the ground line, so that the water line is 9 inches also below the ground. The bottom width of canal is here 12 feet, and the side slopes being $1\frac{1}{2}$ to 1, a waterway of 21 feet is necessary. There will consequently be 2 spans of 10' 6" each.

Construction.

All the masonry to be of the best burnt brick and lime. The tressels, beams, and corbels to be of babool wood with deodar wood baulks and railings, and the filling in of the roadway to be supported by mats laid over kirul rafters. All the timber work to be well tarred. The filling in of roadway and approaches to be well rammed and watered, and the latter to have a longitudinal slope of 1 in 15 and side slopes of $1\frac{1}{2}$ to 1.

MEASUREMENTS.

Excavating Foundation.

	N.	L.	B.	D.	Solid Feet.
Retaining wall of towing path	2	13-00	3-50	3-00	273-00
Do. do. circular portion	4	11-28	3-50	3-00	473-76
Abutments	2	14-00	2-50	2-00	140-00
Wing walls	4	4-50	2-50	2-00	90-00
Tressel bed	1	15-00	0-83	4-66	58-33
Total solid feet excavating foundation					1,035-02

Filling in Foundation with Pucka Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
Retaining wall of towing path	2	13-00	Mean. 3-25	3-00	253-50
Do. do. circular portion	4	11-28	3-25	3-00	439-92
Abutments	2	Mean. 13-50	Mean. 2-375	2-00	128-25
Wing walls	4	4-50	Mean. 2-375	2-00	85-50
Total solid feet filling in foundation with pucka brick and lime..					907-17

Superstructure—Pucka Brick and Lime

	N.	L.	B.	D.	Solid Feet.
Retaining wall of towing path	2	31-00	Mean. 2-00	8-	416-00
Do. do. circular portion	4	11-28	2-00	8-	721-92
Abutments	2	13-00	Mean. 1-75	7-25	329-875
Wing walls	4	Mean. 4-75	Mean. 1-75	7-25	241-062
Total solid feet superstructure burnt brick and lime....					1,708-857

Babool Wood.

	N.	L.	B.	D.	Solid Feet.
Tressel sill	1	15-00	0-83	0-66	8-333
Do. top pace	1	11-00	0-83	0-66	6-111
Do. side paces	2	16-00	0-83	0-66	17-777
Corbels	6	5-00	0-75	0-75	16-875
Beams	6	11-50	0-75	0-75	38-812
Wall plates	2	13-00	0-75	0-75	14-625

Total solid feet babool wood.... 102-533

Deodar Wood.

	N.	L.	B.	D.	Solid Feet.
Baulks	5	13-00	0-416	0-416	11-285
Ditto	4	11-00	0-416	0-416	7-639
Railing (top)	2	35-00	0-416	0-416	12-153
Do. (middle)	2	35-00	0-33	0-33	7-777
Do. (uprights)	7	3-00	0-33	0-33	...
Do. (struts)	2-5	2-50	0-25	0-16	...
Side planks to retain roadway	2	22-00	1-00	0-16	7-333

Total solid feet deodar wood.... 54-144

Roadway—Kirul Rafters and Grass Mats.

	N.	L.	B.	Square Feet.
Roadway over bridge	1	21	8	168-00

Total square feet roadway—kirul rafters, &c.... 168-00

Earthwork filling in.

	N.	L.	B.	D.	Solid Feet.
Roadway over bridge	1	21-00	8-00	1-00	168-00
Between walls	2	7-00	mean. 10-00	8-50	1,190-00
Approaches	2	127-50	mean. 21-50	8-50 2	23,300-625

Total solid feet earthwork filling in.... 24,658-625

<i>Screws, iron (2'10" long).</i>		Number.
Iron screws as above		12
Total Number of iron screws, &c....		12

ABSTRACT.

Quantities or Number	Description of Work, and Rate.	Amount.
		Rs. a. p.
1,035.09 solid feet	Excavating foundation at Rs. 9-12-0 per 100 solid feet	7 12 1
907.17 "	Filling in foundation with burnt brick and lime at Rs. 23 per 100 solid feet	208 10 5
1,768.857 "	Superstructure, burnt brick and lime at Rs. 25 per 100 solid feet	427 3 5
102.533 "	Babool wood at Rs. 1-8-0 per 100 solid feet	153 12 9
54.144 "	Deodar wood at Rs. 2 per solid foot	108 4 1
168.00 sq. feet.	Roadway, kirul rafters, &c. at Rs. 12 per 100 square feet	20 2 7
24,658.625 solid feet	Earthwork filling at Rs. 3-8-0 per 100 solid feet	86 4 11
12 number ..	Iron screws, &c. &c., at Rs. 1 per each....	12 0 0
Total Rupees		1,024 2 9
Add Contingencies 5 per cent.....		51 3 4
Grand total.... Rupees		1,075 6 1

72ND MILE BRIDGE.

General Descriptions.

This bridge is to be built in the 3rd furlong of the 72nd mile, where the water line is 1 foot above the ground line, the depth of excavation being only 5 feet. The bottom breadth of the canal at this point is 10'4", and a waterway of 20 feet is necessary, or two spans of 10 feet each. This is also a masonry and timber bridge combined, and the general description agrees with that already given for a bridge of this kind when the water line is above the ground, except that no towing path will be required.

Construction.

Same as for the 68th mile bridge.

MEASUREMENTS.*Excavating Foundation.*

	N.	L.	B.	D.	Solid Feet.
Abutments.....	2	13·00	5·5	3·0	429·00
Water wings	4	11·28	3·5	3·0	473·76
Wing walls.....	4	5·75	2·5	2·0	115·00
Tressel bed.....	1	15·00	0·83	4·66	58·33
Total solid feet excavating foundation....					1,076·09

Filling in Foundation with Burnt Brick and Lime.

	Solid Feet.
Same as excavating foundation (deducting tressel bed)	1,017 76
Total solid feet filling in foundation, burnt brick and lime	1,017·76

Superstructure Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
			Mean.		
Abutments	2	13·00	3·30	14·00	1,092·00
Water wings	4	11·28	2·00	8·00	721·92
Wing walls.....	4	7·75	2·00	8·00	496·92
Total solid feet superstructure, burnt brick and lime....					2,309·92

Babool Wood.

	N.	L.	B.	D.	Solid Feet.
Tressel side	1	15·00	0·83	0·66	8·333
Do. top pace.....	1	11·00	0·83	0·66	6·111
Do. side paces	2	16·00	0·83	0·66	17·777
Corbels	6	5·00	0·75	0·75	16·875
Beams.....	6	11·00	0·75	0·75	37·125
Wall-plates.....	2	13·00	0·75	0·75	14·625
Total solid feet babool wood....					100·846

Deodar Wood.

	N.	L.	B.	D.	Solid Feet.
Baulks	5	13-00	0-416	0-416	11-285
Do.	4	11-00	0-416	0-416	7-639
Rail top	2	34-00	0-416	0-416	11-806
Do. middle	2	34-00	0-33	0-33	7-555
Do. uprights	2×7	3-00	0-33	0-33	7-332
Do. struts	2×5	2-50	0-25	0-16	0-625
Side planks to retain roadway	2	21-00	1-00	0-16	7-000
Total solid feet deodar wood....					53-242

	N.	L.	B.	Sq. Feet.
<i>Roadway Kirul Rafters and Grass Mats.</i>				
Roadway over bridge	1	20	8-00	160-00
Total square feet roadway kirul rafters, &c....				160-00

	N.	L.	B.	D.	Solid Feet.
<i>Earthwork, Filling in.</i>					
Roadway over bridge	1	20-00	8-00	1-00	160-00
Between wing walls	2	7-00	Mean. 10-00	10-00	1,400-00
Approaches	2	150	Mean. 23-00	Mean. 5-00	34,500-00
Total solid feet earthwork filling in....					36,060-00

	Number.
<i>Screws, Iron (2' 10" long).</i>	
Same as above.....	12
Total number of screws, &c.	12

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
1,076.09 solid feet.	Excavating foundation at Rs. 0-12-0 per 100 solid feet	Rs. a p. 8 1 2
1,017.75 „ ..	Filling in foundation with burnt brick and lime at Rs. 23 per 100 solid feet	234 1 4
2,309.92 „ ..	Superstructure, burnt brick and lime at Rs. 25 per solid feet	577 7 8
100.846 „ ..	Babool wood at Rs. 1-8-0 per solid foot ..	151 4 4
53.242 „ ..	Deodar wood, including dammer at Rs. 2 per solid foot	106 7 9
160.000 sq. feet.	Roadway kirul rafters and grass mats at Rs. 12 per square foot	19 3 2
36,060.00 solid feet.	Earthwork filling in at Rs. 3-8-0 per 1,000 solid feet	126 3 4
12 number	Screws, iron (2' 9 1/2" long) at Rs. 1 per each.	12 0 0
Total Rupees....		1,234 12 9
Add—Contingencies at 5 per cent....		61 11 10
Grand Total....		1,296 8 7

75TH MILE BRIDGE M. C.

This bridge is to be built in the 8th furlong of the above mile, and to be of masonry and timber combined, the ground line being 6 inches above water line. The bottom breadth of canal at this point is 8½ feet, and a waterway of 17' 6" is necessary. There will be two spans of 8' 9" each.

CONSTRUCTION.

Similar to that described for the original design.

Excavating Foundation.

	N.	L.	B.	D.	Solid Feet.
Retaining wall of towing path	2	13.00	3.50	3.00	273.00
Water wings to ditto	4	11.28	3.50	3.00	473.76
Abutments.....	2	14.00	2.50	2.00	140.00
Wing walls	4	4.50	2.50	2.00	90.00
Tressel bed.....	1	15.00	0.83	0.66	58.33
Total solid feet excavating foundation....					1,035.09

Filling in Foundation with Burnt Brick and Lime.

Same as for the 68th mile bridge

Total solid feet filling in foundation with burnt brick and lime..

Solid Feet.

907-17

907-17

Superstructure, Burnt Brick and Lime.

Same as 68th mile bridge

Total solid feet superstructure, burnt brick and lime....

Solid Feet.

1,708-857

1,708-857

Babool Wood.

Tressel sill

Do. top pace

Do. side paces

Corbels

Beams

Wall plates.....

No.	L.	B.	D.	Solid Feet.
1	15-00	0-83	0-66	8-333
1	11-00	0-83	0-66	6-111
2	16-00	0-83	0-66	17-777
6	5-00	0-75	0-75	16-875
6	9-75	0-75	0-75	32-906
2	13-00	0-75	0-75	14-625

Total solid feet babool wood....

96-627

Deodar Wood.

Baulks.....

Do.

Rail top

Do. middle

Do. upright.....

Do. struts

N.	L.	B.	D.	Solid Feet.
5	13-00	0-416	0-416	11-285
4	11-00	0-416	0-416	7-639
2	31-50	0-416	0-416	10-937
2	31-50	0-33	0-33	7-000
11	3-00	0-33	0-33	3-666
5	2-50	0-25	0-16	0-625

Total solid feet deodar wood....

41-152

Roadway Kirul Rafters and Grass Mats.

Roadway over bridge

N.	L.	B.	Square Feet.
1	17-5	8	140-00

Total square feet roadway kirul rafters, &c....

140-00

110035

Earthwork Filling in.

	No.	L.	B.	D.	Solid Feet.
Roadway over bridge	1	17.5	8.00	1	140.000
Between wing walls	2	7.00	10.00	8.75	1,225.000
			Mean.		
Approaches.....	2	131.25	21.76	8.75	24,978.515
			2		
Total solid feet earthwork filling in....					26,343.515

Screws, Iron (2' 10" long).

	Number.
Screws as above	12
Total number of screws, iron, &c....	12

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
1,035.09 solid feet.	Excavating foundation at Rs. 0-12-0 per 100 solid feet	7 12 1
907.17 "	Filling in foundation with burnt brick and lime at Rs. 23 per 100 solid feet	208 10 5
1,708.857 "	Superstructure burnt brick and lime at Rs. 25 per 100 solid feet.....	427 3 5
96.627 "	Babool wood at Rs. 1-8-0 per solid foot ..	82 4 10
41.152 "	Deodar wood at Rs. 2 per solid foot	16 12 10
140.00 sq. feet..	Roadway kirul rafters, &c., at Rs. 12 per 100 square feet	92 3 3
26,343.515 solid feet	Earthwork filling at Rs. per 100 solid feet..	12 0 0
12 number ..	Screws, iron, long at Rs. 1 per each	
Total Rs....		991 13 10
Add—Contingencies at 5 per cent....		49 9 6
Grand total Rs....		1,041 7 4

79TH MILE BRIDGE M. C.

This bridge will be built in the 3rd furlong of this mile where the Durrialla Branch takes off, and will be connected with the Regulating Bridge at the head of that branch. It is to be a masonry bridge, and consists of two spans of 8 feet each, the pier being 2' 6" thick, and the abutments 3 feet thick. Up and down stream water wings are provided, the left bank up stream one being longer than the other, and joining on to the right bank up stream water wing of the Durrialla Branch Bridge. The foundations of the piers and abutments are 6 feet deep, built in 4 steps of 1' 6" each, with an offset of 3" on each side at each step, so that the abutments are 5 feet thick, and the pier 4 feet 6 inches at bed of foundation. The waterwings are built in steps, as shown in the drawing, the up stream one being 4' 3" thick at bed of foundation and 8 feet high above bed of canal, and the down stream ones 3' 9" thick at foundation and 6 feet high. The up stream water wings are 2 feet thick at top, and the down stream ones 1' 6". The arches to spring from a height of 8 feet from the bed of the canal, or 2 feet above the ordinary water line, and to have a rise of 2 feet, the thickness of arch ring being 1 foot; a flight of steps is provided, as shown in the plan, and the retaining wall of this, as well as the up stream wing wall, which is connected with the branch bridge, are to have their foundations 4 feet below the ground line; the remaining wing walls are to have their foundations at the level of the bed of the canal. To prevent a scour under the bridge, a pavement or flooring 1' 6" thick of burnt brick on edge is provided, extending from 8 feet in front of, to 20' 6" in rear of, the gate sill; the portion of pavement immediately in rear of the gate sill is, for a distance of 6 feet, 3 feet thick. The gate sill is 2 feet thick at top and 2' 9" at bottom, the foundations being 6 feet thick, built in 4 steps of 1' 6" each. To support the pavement in rear a curtain wall is built. This wall is 6 feet deep, built in 4 steps of 1' 6" each, being 1' 6" thick at top and 2' 3" at bottom, and to strengthen this wall the line of pier is produced and built up with it to the level of the bed of canal, thus acting as a counterfort. The regulating apparatus consists of horizontal babool wales with vertical filling in pieces of the same material, these wales being 8" $\times$ 7", and let 4" into the masonry at each end, and vertical

teak baulks 9' 6" long and 5" × 5", with teak wood straining pieces 8 feet long and 3 inches wide, let 6 inches into the face of the abutments. Two teakwood gauges are also provided, the upper one being 8' × 4" × 2" and the lower one 6' × 4" × 2". The approaches to have a longitudinal slope of 1 in 15, with side slopes of $1\frac{1}{2}$ to 1. The depth of excavation of canal at site of bridge is 6 feet.

CONSTRUCTION.

All the masonry to be of the best burnt brick and lime.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Abutments, including pilasters.	2	15.0	5.0	6.0	900.00	
Pier (as far as rear curtain wall)	1	26.66	4.5	6.0	720.00	
Up stream water wing left bank	1	20.00	4.25	6.0	510.00	
Do. do. do. right do.	1	12.50	4.25	6.0	318.75	
Down stream water wings....	2	12.50	3.75	6.0	562.50	
Wing walls.....	3	16.50	3.50	6.0	1039.50	
Up stream wing wall left bank	1	12.50	3.5	6.0	262.50	
Steps	1	6.0	3.0	2.0	36.00	
Retaining wall to steps	1	7.50	2.5	4.0	75.00	
Pilaster to do.	1	2.00	1.0	4.0	8.00	
Retains to water wings.....	2	2.75	1.0	6.0	33.00	
Do. do.	1	2.25	1.0	6.0	13.50	
Newels to wing walls	3	3.75	3.25	6.0	219.375	
		Mean.				
Pavement in front of gate sill.	1	18.25	8.00	1.5	219.000	
Gate sill	2	6.00	2.75	6.0	198.000	
Pavement (as far as end of abutments)	2	12.25	6.00	1.5	220.500	
Do. (portion).....	1	5.25	6.00	1.5	94.50	
			Mean.			
Pavement (up to rear curtain wall)	2	6.75	7.00	1.5	141.750	
Rear curtain wall	2	8.00	2.25	6.0	216.000	5,740.625
<i>Deduct.</i>						
Cut water of pier (front)	1	2.66	4.5	6.0	72.000	72.000
Total solid feet excavating foundation.....						5,763.135

<i>Filling in Foundation with Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters.	2	15·0	4·25	6	765·00	
Pier (as far as rear curtain wall)	1	26·66	3·75	6	600·00	
Up stream water wing left bank	1	20·00	3·875	6	465·00	
Do. do. right do.	1	12·50	3·875	6	290·625	
Down stream water wings....	2	12·50	3·375	6	506·250	
Wing walls.....	3	16·5	3·000	6	891·000	
Up stream wing and wall left bank	1	12·50	3·00	6	225·000	
Steps	1	6·00	3·25	2	39·000	
Retaining wall to steps	1	7·50	2·375	4	71·250	
Pilaster to do. do.	1	2·00	1·00	4	8·000	
Retains to water wings.....	2	3·125	1·00	6	37·500	
Do. do.	1	2·625	1·00	6	15·750	
Newells to wing walls	3	3·50	3·00	6	189·000	
Pavement in front of gate sill	1	19·75	8·00	1·5	273·000	
Gate sill	2	6·75	2·375	6·0	192·375	
Pavement (as far as end of abutment)	2	13·00	7·50	1·5	292·500	
Do. (portion).....	1	5·75	7·00	1·5	120·75	
Pavement up to rear curtain wall.....	2	7·50	8·50	1·5	191·250	
Rear curtain wall	2	9·5	1·875	6	213·750	5,290·625
<i>Deduct.</i>						
Cutwater of pier front	1	2·66	3·75	6	60·000	60·000

Total solid feet filling in foundation with burnt brick and lime .. 5,291·000

SUPERSTRUCTURE.	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Burnt Brick and Lime.</i>						
Abutments (including pilasters)	2	15·00	3·00	8·00	720·00	
Pier, including cutwater..	1	19·33	2·50	8·00	386·60	
Up stream water wing left bank	1	20·00	2·375	8·00	380·00	
Do. do. right do.	1	12·50	2·375	8·00	237·50	
Down stream water wings	2	12·50	1·75	6·00	262·50	

SUPERSTRUCTURE— (continued.)	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Burnt Brick and Lime— (continued.)</i>						
Wing walls.....	3	16.50	20.0	2.00	198.00	
Do.	3	16.50	1.75	1.75	151.59375	
Do. up to crown of arch	3	16.50	1.50	1.25	92.8125	
Up stream wing wall left bank (portion)	1	12.5	2.00	2.00	50.000	
Do. do. do..	1	12.5	1.75	1.75	38.28125	
Do. do. do..	1	12.5	1.50	1.25	23.4375	
Steps	1	6.0	3.50	4.00	84.000	
Retaining wall to steps (portion).....	1	7.5	2.00	1.50	22.500	
Do. do. do..	1	7.5	1.75	1.83	24.0625	
Do. do. do..	1	7.5	1.375	2.66	27.5000	
Landing	1	2.5	4.00	1.50	15.0000	
Parapet wall to retaining wall.....	1	7.5	1.00	2.00	15.0000	
Pilaster to do. up to coping	1	2.00	1.00	8.00	16.0000	
Returns to water wings..	2	3.5	1.00	6.00	42.0000	
Do. do. ..	1	3.0	1.00	8.00	24.0000	
Newels to wing walls (portion).....	3	3.0	2.50	2.00	45.0000	
Do. do. do..	3	2.75	2.25	1.75	31.9687	
Do. do. do..	3	2.50	2.00	1.25	18.75000	
Face walls (up stream 51.50, down 55.50)....	1	107.00	1.25	1.00	133.7500	
Do. do. (Newels) ..	3	2.25	1.75	1.00	11.8125	
Parapet walls (up stream 49.50, down 55.50) ..	1	105.0	1.00	2.00	210.00	
Do. do. (Newels) ..	3	2.00	1.50	2.00	18.00	
Pilaster to abutments up to coping	4	2.00	1.00	6.00	24.00	
Do. do. do..	2	2.00	1.00	8.00	32.00	
Caps to cut waters	2	3.00	3.00	1.00	18.00	
Skew backs to abutments.	2	12.00	2.625	0.75	47.25	
Do. to piers	1	12.00	1.750	0.75	15.75	
Backing to abutments ..	2	12.00	Area 5.25		126.00	
Do. to piers	2	12.00	Area 3.00		72.00	
Spandril walls	4	1.50	Area 4.375		26.625	
Do. do.	2	1.5	Area 7.875		23.625	
Total solid feet superstructure burnt brick and lime....						3,664.9437

Archwork—Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
Arches	2	12.00	10.198	1.0	244.752

Total solid feet archwork burnt brick and lime 244.752

String Course.

	N.	L.	Running Feet.
Face wall up stream including pilasters and newels	1	55.50	55.50
Side do. down stream do. do. do.	1	61.50	61.50
Retaining wall to steps, including pilaster	1	9.50	9.50

Total running feet string course 126.50

Coping.

	N.	L.	Running Feet.
Parapet wall up stream	1	51.50	51.50
Do. down stream	1	55.50	55.50
Pilaster to abutments	4	2.00	8.00
Newels to wing walls	3	2.00	6.00
Retaining wall to steps	1	7.50	7.50
Pilaster to do.	1	2.00	2.00

Total running feet coping 130.50

Babool Wood.

	N.	L.	B.	D.	Solid Feet.
Wales	8	8.66	0.66	0.583	26.963
Filling-in pieces	4	8.00	0.66	0.33	7.111

Total solid feet babool wood 34.074

Teak Wood.

	N.	L.	B.	D.	Solid Feet.
Vertical baulks	48	9.5	0.416	0.416	79.166
Straining pieces	4	8.0	0.50	0.250	4.000
Guage up stream	1	8.0	0.33	0.16	0.444
Do. down do.	1	6.0	0.33	0.16	0.333

Total solid feet teak wood 83.943

Earthwork.

	N.	L.	B.	D.	Solid Feet.
Between spandril walls	2	9.0	Area	4.395	76.7500
Do. do. do.	1	9.0	7	875	74.775
Roadway over bridge	1	24.5	9.5	1.0	232.7500
			Mean.		
Between wing walls right bank	1	15.0	8.75	6.0	787.5000
			Mean.		
Do. do. left do.	1	11.0	14.25	6.0	940.5000
			Mean.		
Do. do. do. do. fraction.	1	20.5	4.5	6.0	553.5000
			Mean.	Mean.	
Approaches right bank	1	90.0	26.00	3.00	7,020.0000
			Mean.		
Half ditto left bank	1	90.0	10.00	3.00	2,700.0000

Total solid feet earthwork 12,454.75

N.B.—In the superstructure, the pilasters have been calculated as square, to make allowance for the extra labour in cutting the bricks to the proper shape. The measurements in this bridge have been calculated up to the line shown in plan dividing it from the branch bridge, hence only half the approach or the left bank is shown.

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.		
		Rs.	a.	p.
5,763·125 solid feet	Excavating foundation at Rs. 0-12-0 per 100 solid feet	43	3	5
5,291·000 „	Filling in foundation with burnt brick and lime at Rs. 23 per do. do.	1,216	14	11
3,664·9437 „	Superstructure do. do. at Rs. 25 per do. do.	916	3	9
244·752 „	Archwork do. do. at Rs. 32-8-0 per do. do.	79	8	8
126·500 rg. ft.	String course at Rs. 15 per 100 running feet	18	15	7
130·500 „	Coping at Rs. 0-8-0 per running foot.....	65	4	0
34·074 solid ft.	Babool wood at Rs. 1-8-0 per solid foot ..	51	1	9
83·943 „	Teak wood at Rs. 4-4-0 per do. do. ..	356	12	1
12,454·75 * „	Earthwork at Rs. 3-8-0 per 1,000 solid feet	43	9	6
Total....Rs.		2,791	9	8
•Add—Contingencies at 5 per cent....		139	9	3
Grand total....Rs.		2,931	2	11

82ND MILE BRIDGE M. C.

This bridge will be built in the 82nd mile of the canal in the 8th peg of the mile. It will also be a masonry and timber bridge, and as the ground line is 9" (the depth of cutting being 4' 9") above the water line, the design is the same as that of the 68th mile bridge. The bottom breadth of canal is here 4 feet, and as the depth of water is also 4 feet, and side slopes of canal $1\frac{1}{2}$ to 1, the waterway necessary is 10 feet, which is provided for, being one span of that width.

CONSTRUCTION.

Same as for the 68th mile bridge.

MEASUREMENTS.

Excavating Foundation.

Same as for the 68th mile bridge

Total solid feet excavating foundation....

Solid Feet.
1,035·09
1,035·09

Filling in Foundation with Burnt Brick and Lime.

	Solid Feet.
Same as for the 68th mile bridge	907·17
Total solid feet filling in foundation, &c....	907·17

Superstructure, Burnt Brick and Lime.

	Solid Feet.
Same as for the 68th mile bridge	1,708·857
Total solid feet superstructure, burnt brick and lime....	1,708·857

Babool Wood.

	N.	L.	B.	D.	Solid Feet.
Corbels	6	2·50	0·75	0·75	8·437
Beams	3	12·00	0·76	0·75	20·250
Wall plates	2	13·00	0·75	0·75	14·625
Total solid feet babool wood....					43·312

Deodar Wood.

	N.	L.	B.	D.	Solid Feet.
Baulks	3	13·00	0·416	0·416	6·771
Do.	2	11·00	0·416	0·416	3·819
Rail top	2	24·00	0·416	0·416	8·333
Do. middle	2	24·00	0·416	0·416	8·333
Do. uprights	2×5	3·00	0·33	0·33	3·333
Do. struts	2×1	2·50	0·25	0·16	0·208
Side planks to retain earth of roadway..	2	10·00	1·00	0·16	3·333
Total solid feet deodar wood....					34·130

Roadway Kirul Rafters and Grass Mats.

	N.	L.	B.	Solid Feet.
Roadway over bridge.....	1	10·00	80·00	80·00
Total square feet roadway kirul rafters and grass mats....				80·00

Earthwork, Filling in.

	N.	L.	B.	D.	Solid Feet.
Roadway over bridge	1	10-00	8-00	1-00	80-00
Between wing walls	2	7-00	Mean. 10-00	10-75	1,505-00
Approaches	2	161-25	23-75	10- $\frac{1}{2}$	41,169-14

Total solid feet earthwork filling in 42,754-14

SCREWS, IRON (2'10" LONG).

Screws

Total number of screws, iron (2'10" long)

Number.
12
12

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
1,035-09 solid feet	Excavating foundation at Rs. 0-12-0 per 100 solid feet.....	7 12 1
907-17 " "	Filling in foundation burnt brick and lime at Rs. 23 per 100 solid feet	201 10 5
1,708-857 " "	Superstructure, burnt brick and lime at Rs. 25 per solid feet	427 3 5
43-312 " "	Babool wood at Rs. 1-8-0 per solid foot.	64 15 6
34-130 " "	Deodar wood at Rs. 2 per solid foot.....	68 4 2
140-000 sq. feet	Roadway kirul rafters, &c. at Rs. 12 per 100 square feet.....	16 12 10
42,754-14 solid feet	Earthwork filling in at Rs. 3-8-0 per 100 solid feet	149 10 3
12 number	Screws, iron, 2'10" long at Rs. 1 per each	12 0 0
Total....Rs.		955 4 8
Add—Contingencies at 5 per cent....		47 12 3
Grand total....Rs.		1,003 0 11

85TH MILE BRIDGE M. C.

This bridge will be built in the 8th furlong of this mile. The depth of cutting here is 4 feet, so that the water line is level with the ground line. The design and dimensions of waterway are the same as those of the 82nd mile bridge.

CONSTRUCTION.

Same as the 82nd mile bridge.

MEASUREMENTS.

All the items of the measurements are the same as those of the 82nd mile bridge, with the exception of "earthwork filling in," the measurements of which are as follows:—

EARTHWORK FILLING IN.	N.	L.	B.	D.	Solid Feet.
Loading over bridge	1	10-00	8-00	1-00	80-000
			Mean.		
Between wing walls	2	7-00	10-00	11-25	1,575-000
Approaches	2	168-75	24-85	11-25	46,037-109
			2		
Total solid feet earthwork filling in....					47,692-109

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
1,035-09 solid feet.	Excavating foundation at Rs. 0-12-0 per	Rs. a. p.
	100 solid feet	7 12 1
907-17 " "	Filling in foundation, burnt brick and	
	lime, at Rs. 23 per 100 solid feet	208 10 5
1,708-857 " "	Superstructure do. do. at	
	Rs. 25 per 100 solid feet	427 3 5
43-312 " "	Babool wood at Rs. 1-8-0 per solid foot.	64 15 6
34-130 " "	Deodar wood at Rs. 2 per solid foot.....	68 4 2
140-000 sq. "	Roadway kirul rafters, &c. &c. at Rs. 12	
	per 100 square feet	16 12 10
47,692-109 solid feet.	Earthwork filling in at Rs. 3-8-0 per	
	1,000 solid feet	166 15 9
12 number	Screws, iron 2' 10" long at Rs. 1 per	
	each	12 0 0
Total....Rs.		972 10 2
Add—Contingencies at 5 per cent....		48 10 1
Grand total....Rs.		1,021 4 3

TAIL SLUICE.

Connected with the sluice, is a roadway bridge 10' 6" wide between the parapets. It is to be of one span 10 feet wide with a rise of 2 feet, the thickness of arch ring being 1 foot. The abutments are 3' 6" thick. Up and down stream water wings are provided, and the foundations of these, as well as those of the abutments, are 4' 6" below the bed of the canal, built in steps of 1' 6" each. The abutments are 5 feet thick at foundation, and the water wings as follows:—

Up streams 3 feet thick and down stream 2' 6". The up stream water wings are 6 feet high above the bed of the canal, or 2 feet above ordinary water line, and 1' 6" thick at top, and the down stream 4 feet high and 1 foot thick at top. Wing walls are provided, as shown in this drawing. The arrangement for the pavement, gate sill, and rear curtain wall is very similar to that described for the 79th mile bridge, and the regulating apparatus also consists of the same arrangement of babool wales and vertical teak baulks. The approaches to have a longitudinal slope of 1 in 15, and side slopes of $1\frac{1}{2}$ to 1. The depth of excavation of canal at the site of this bridge is 4 feet.

CONSTRUCTION.

The whole of the masonry to be of the best burnt brick and lime.

MEASUREMENT.

<i>Excavating Foundation.</i>	N.	L.	B.	D.	Solid Feet.
Abutments, including pilasters	2	14.5	5.0	4.5	652.50
Water wings up stream	2	10.5	3.0	4.5	283.50
Returns to do.	2	2.5	1.0	4.5	22.50
Water wings down stream	2	10.5	2.5	4.5	236.25
Returns to do.	2	2.5	1.0	4.5	22.50
Wing walls	4	12.5	2.5	4.0	500.00
Newels	4	3.75	1.75	4.0	105.00
		Mean.			
Pavement in front of gate sill	1	10.5	6.00	1.5	94.50
Gate sill	1	8.5	2.5	4.5	95.625
Pavement as far as end of abutments ..	1	13.0	8.5	1.5	165.750
			Mean.		
Do. up to rear curtain wall	1	5.0	9.5	1.5	71.250
		Mean.			
Rear curtain wall	1	11.5	2.0	4.5	103.500
Portion of pavement in rear of gate sill .	1	7.5	8.5	1.5	95.625
Total solid feet excavating foundation ...					2,448.50

<i>Filling in Foundation with Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.
Abutments, including pilasters	2	14.5	Mean. 4.5	4.5	587.25
Water wings up stream	2	10.5	Mean. 2.75	4.5	259.875
Returns to do.	2	2.5	1.00	4.5	22.500
Water wings down stream	2	10.5	Mean. 2.25	4.5	212.625
Returns to do.	2	2.5	1.00	4.5	22.500
Wing walls	4	12.5	Mean. 2.375	4.00	475.000
Newels	4	3.625	1.75	4.00	101.500
Pavement in front of gate sill	1	11.500	6.00	1.50	103.500
Gate sill	1	9.00	2.25	4.5	91.125
Pavement as far as end of abutment ..	1	13.50	9.50	1.5	192.375
Do. up to rear curtain wall	1	5.50	10.75	1.5	84.6875
Rear curtain wall	1	12.50	1.75	4.5	98.4375
Portion of pavement in rear of gate sill.	1	7.75	9.0	1.5	104.6250
Total solid feet excavating foundation....					2,356.0000

<i>Superstructure of Burnt Brick & Lime.</i>	N.	L.	*B.*	D.	Solid Feet.
Abutments, including pilasters up to springing.....	2	14.5	3.5	6.0	609.00
Skew backs	2	3.125	12.5	0.75	58.593
Backing ..	2	12.5	Area. 4.50		112.500
Spandril walls.....	4	1.5	Area. 5.40		30.0000
Water wings up stream.....	2	10.5	1.75	6.0	220.5000
Returns to do.	2	2.5	1.00	6.0	30.0000
Water wings down stream.....	2	10.5	1.25	4.0	105.0000
Returns to do.	2	2.5	1.00	4.0	20.0000
Wing walls	4	12.5	Mean. 1.875	4.0	375.0000
Ditto	4	12.5	1.50	1.0	75.0000
Newels	4	3.125	1.75	4.0	87.5000
Ditto	4	2.75	1.75	1.00	19.2500
Face wall	2	42.00	1.25	1.00	105.0000
Do. newels	4	2.50	1.75	1.00	17.5000
Parapet wall	2	42.00	1.00	1.50	126.0000
Do. newels	4	2.25	1.75	1.50	23.6250
Pilasters to abutments from springing line to coping.....	4	2.50	1.00	5.5	55.0000
Total solid feet superstructure burnt brick and lime....					2,069.468

Arch Work, Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
Arch	1	11.795	12.5	1.0	147.4375
Total solid feet arch work, burnt brick and lime					147.4375

String Course.

	N.	L.	Running Feet.
To face walls, including pilasters and newels ..	2	51.0	102.00
Total running feet string course			102.00

Coping.

	N.	L.	Running Feet.
Parapet wall	2	42.00	84.00
Pilasters to abutments	4	2.50	10.00
Newels to wing walls	4	2.25	9.00
Total running feet coping			103.00

Babool Wood.

	N.	L.	B.	D.	Solid Feet.
Wales.....	4	10.66	0.66	0.583	76.593
Filling in pieces.....	2	6.00	0.66	0.33	2.666
Total solid feet babool wood....					19.259

Teak Wood.

	N.	L.	B.	D.	Solid Feet.
Baulks	24	7.5	0.416	0.416	31.250
Straining pieces.....	2	6.0	0.50	0.25	1.500
Gauge up stream	1	6.0	0.33	0.16	0.333
Do. down do.....	1	4.0	0.33	0.16	0.222
Total solid feet teak wood....					33.305

Earth Work.

	N.	L.	B.	D.	Solid Feet.
Between spandril walls.	2	10-0	Area 5-00 Mean.		100-00
Do. wing walls	2	10-25	14-25	6-00	1,752-75
Roadway over bridge	1	17-00	10-00	1-00	170-00
Approaches	2	90-	Mean. 27-00	Mean. 3-00	14,580-00
Total solid feet earth work....					16,602-75

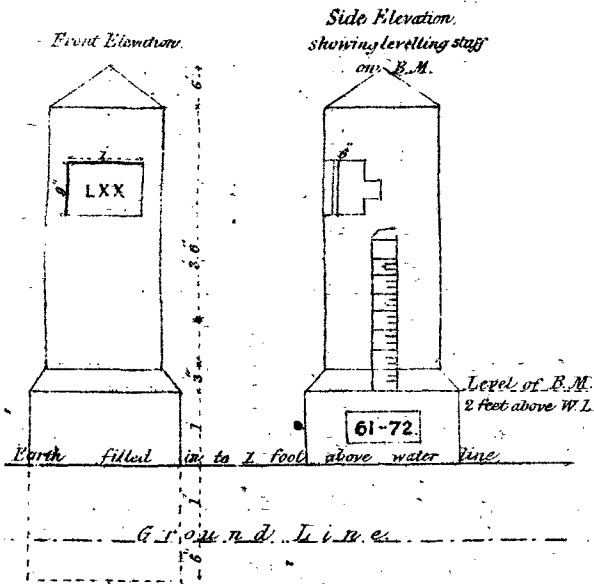
ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
2,448-50 solid feet.	Excavating foundation at Rs. 0-12-0 per 1,000 solid feet.....	18 5 10
2,356-00 „	Filling in burnt brick and lime at Rs. 23 do.	541 14 1
2,069-468 „	Superstructure do. do. at Rs. 25 do. do.	517 5 10
147-4375 „	Arch work do. do. at Rs. 32-8-0 do. do.	47 14 8
102-000 sq. ft.	String course at Rs. 15 per 100 running feet.	15 4 10
103-000 „	Coping at Rs. 0-8-0 per running foot	51 8 0
19-259 solid ft.	Babool wood at Rs. 1-8-6 per solid foot ..	28 14 2
33-305 „	Teak wood at Rs. 4-4-0 per do. do. ..	141 8 9
16,602-75 „	Earth work at Rs. 3-8-0 per 1,000 solid foot.	58 1 9
Total....Rs.		1,420 13 11
Add—Contingencies at 5 per cent....		71 10 5
Grand total....Rs.		1,492 8 4

MILE STONES AND BENCH MARKS COMBINED.

These are to be built every mile, and to be of pukka brick and lime. The foundation to be 2 feet square and 6 inches below the ground line, the level of the bench mark to be 2 feet above water line.

The superstructure to be 3' 6" high, and to have a cap at top 6" high. Two stones will be required, on one of which will be cut the number of the mile, and on the other the reduced level of the bench mark. A general idea of the average cost of each mile stone and bench mark can be formed if, as in the following instance, the ground line and water line are supposed to be equal.



MEASUREMENTS.

Excavating Foundation.

Foundation

N.	L.	B.	D.	Solid Feet.
1	2	2	0.6	2.00
Total solid feet excavating foundation....				2.00

Masonry Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
Foundation and plinth, lower portion ..	1	2.0	2.0	2.5	10.00
Plinth, upper portion	1	1.75	1.75	0.25	0.766
Superstructure	1	1.5	1.5	3.5	7.875
Cap	1	1.5	1.5	<u>1.5</u> 2	1.125
Total solid feet masonry burnt brick and lime....					19.776

Stones (cut and lettered).

Mile stone and bench mark.....

Total number of stones cut and lettered....

Number.
2
2

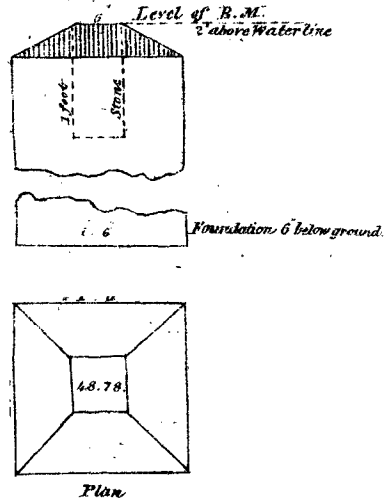
ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
2.00 solid feet...	Excavating foundation at Rs. 0-12-0 per 100 solid feet	0 0 3
19.766 "	Masonry burnt brick and lime at Rs. 30 per do. do.	5 14 1
2 number ..	Stones cut and lettered at Rs. 5 per each..	10 0 0
Total....Rs.		15 15 2
Add—Contingencies at 5 per cent....		0 12 9
Grand total Rs.		16 11 11

. 90 of these bench marks and mile stones will be required, the cost of which will be $90 \times \text{Rs. } 16-11-11$ or Rs. 1,507-0-6.

BENCH MARKS AT FURLONGS.

These bench marks to be built as shown in the accompanying sketches. They are to be 1' 6" square, with foundation 6" below the ground line, and level of top of bench mark 2 feet above the water line. They are to be built of pukka brick and lime, and a stone 1 foot long and 6" square to be let in at the top, and on this stone will be cut the reduced level of the bench mark, as shown in plan. The ground and water lines are again supposed to be equal.



MEASUREMENTS.

Excavating Foundation.

	N.	L.	B.	D.	Solid Feet.
Foundation	1	1.5	1.5	.5	1.125
Total solid feet excavating foundation.....					1.125

Masonry Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Foundations and superstructure.....	1	1.5	1.5	2.25	5.062	
Caps	1	1.0	1.0	0.25	0.250	
Total solid feet masonry burnt brick and lime....						5.312

N.B.—No deduction has been made for the stone to allow for the extra labour of the cap.

Stone cut and lettered.

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
1.125 solid feet ..	Excavating foundation at Rs. 0-12-0 per 100 solid feet	0 0 2
5.312 „ ..	Masonry of burnt brick and lime at Rs. 30 per 100 solid feet.....	1 9 6
1 number	Stone cut and lettered at Rs. 4 each.....	4 0 0
Total....		5 9 8
Add—Contingencies at 5 per cent....		0 4 6
Grand total....		5 14 2
Add for 6 more....		35 5 0
Cost per mile for B.M's 5 at each furlong, excluding the mile stone	Grand total....	41 3 2

For the whole canal the cost will be $88 \times \text{Rs. } 41-13-2$ or Rs. 3,680-6-8.

DOSAH WAH.

The Mitrow Canal in the 30th mile crosses two small canals, which used to receive their water from inundation canals in Sind, but they now take their water from this canal, the old mouths having been closed. These canals are called the Hingomah Wah and Dosah Wah, the former being now about 3 miles long and the latter nearly 10. To give these canals a better and more direct supply of water, a new cut had to be excavated, and a double regulating bridge had to be constructed of two spans, one for each of these canals. The cost of this excavation has been Rs. 503-6-1.

C. E. No. 3436 of 30th December 1862.

REGULATING BRIDGE.

The bridge to consist of two arches of 8 feet and 10 feet span, with a rise in each of 1' 9". The foundation to be carried down 4 feet below the bed of the canal, or 9 feet below the level of the ground. The pavement between the sill wall and front curtain wall to be 2 feet thick brick on edge, between the sill wall and rear curtain wall 1' 6" thick brick on edge, a pavement of brick on edge set dry to extend to 5 feet above the front curtain wall and 10 feet below

the rear curtain wall. The regulating apparatus to consist of deodar baulks 8' long 5" square sliding down vertically against two babool wales 8" × 9" let into the pier and abutment.

The following table shows the amounts expended on the several items of this regulating bridge:—

Description of Work performed.	Amount expended.		
	Rs.	a.	p.
Excavating foundation	37	4	0
Filling in foundation	452	1	6
Superstructure	632	13	2
Archwork	109	9	4
Pavement	109	7	3
Filling in roadway	15	11	8
Contingencies	137	11	6
Total Rs....	1,494	10	5

MASONRY AND TIMBER BRIDGE.

Besides the regulating bridge, it was necessary to construct a bridge across the Dosah Wah, to accommodate the traffic on the Meerpoor and Kissra road, and it was constructed of timber and masonry, similar in design to those across the Mitrow Canal. The work performed on it and the cost are as shown below.

Quantities.	Description of Work performed.	Cost.		
		Rs.	a.	p.
495 solid feet	Excavating foundation	7	13	0
141 " 	Filling in foundation	17	15	0
760 " 	Superstructure	249	5	2
	Wood work, including dammering.....	54	14	6
300 square feet....	Chunam pointing.....	6	7	0
2,785 solid feet....	Filling in roadway	12	12	0
	Contingencies	0	5	0
Total Rs....		349	7	8

The total cost of the Dosah Wah and Hingomah Wah will be seen from the following :—

<i>Recapitulation.</i>		Rs.	a.	p.
Excavation for a new mouth		503	6	1
Regulating bridge at head		1,494	10	5
Timber and masonry bridge over Dosah Wah		349	7	8
Total Rs.,...		2,347	8	2

SAMARA BRANCH CANAL.

This canal takes off from the main line in the 7th furlong of the 5th mile, near Ramjagah, and passing to the west of the small village of Yosoof Bumbro in the 4th mile, skirts, in the 6th and 7th miles, the flood line of 1856 on the edge of Samara Dund. This branch is intended to irrigate country which the water of the main line would not reach, on account of an intervening ridge of high ground, and to throw water into the Dund at Samara (a large town), where there will now be yearly crops raised, instead of these crops being dependent on the extent of the flood water from the Narra. The bottom widths of and depth of water in this canal are as follows, viz :—

Mile.	Bottom breadth.	Depth of Water.
1	5'00	4'50
2	4'50	4'50
3	4'25	4'25
4	4'00	4'00
5	3'00	4'00
6	3'00	4'50
7	3'00	4'00

It has at present only been lined out to the end of the 7th mile, but it is very probable that it will be produced 3 miles more (making it 10 miles), and that it will tail off into an old kurriah, (dug I believe at the expense of Government,) leading from the Samara Dund into a large chain about 2 miles distant and called Tubooee. This branch crosses the following roads, viz. at the commencement of the 2nd mile the road from Ramjagah to Samara, which road will have to be diverted, as it is not worth while making a road bridge to accommodate the traffic on it, besides the bridge which will be required at

the head. It crosses twice (in the 3rd and 6th miles) the road (but seldom used now) from Dingan Pullee to Samara, but no bridge will be required for it, and in the 7th mile it crosses two roads, at their point of junction, leading respectively from Ramjagah (the road mentioned above) and Gorehancee to Samara. The following accessary works will therefore be required, viz. regulating bridge at head (to be connected with the timber and masonry bridge in the 57th mile. M. C.), a masonry and timber bridge in the 4th mile to accommodate the villages in Yosoof Bumbro jo Gote, and a tail sluice (and road bridge) in the 7th mile. The side slopes of canal to be 1 to 1, and the spoil to be thrown to a distance of 5 feet from the edge of the excavation.

Excavation.

Mile.	Furlong.	Half Bottom Breadth of Canal.	Half Top Breadth of Canal.	Depth of Excavation	Area of Section.	Solid Feet every Mile.
Peg at	Head.	2.50	7.82	5.32	54.9024	
"	1	2.50	8.10	5.60	59.3600	
"	2	2.50	7.89	5.39	56.0021	
"	3	2.50	7.84	5.34	55.2156	
"	4	2.50	7.59	5.09	51.3581	
"	5	2.50	7.44	4.94	49.1036	
"	6	2.50	7.03	4.53	43.1709	
"	7	2.50	7.06	4.56	43.5936	
1	8	2.50	6.96	4.46	42.1917	
		2.25	6.71	4.46	39.9616	268,191.627
"	1	2.25	6.65	4.40	39.1600	
"	2	2.25	6.73	4.48	40.2304	
"	3	2.25	7.14	4.89	45.9171	
"	4	2.25	7.21	4.96	46.9216	
"	5	2.25	7.15	4.90	46.0600	
"	6	2.25	7.34	5.09	48.8131	
"	7	2.25	8.21	5.96	62.3415	
2	8	2.25	8.15	5.90	61.3600	250,869.036
		2.125	7.775	6.65	55.9350	
"	1	2.125	8.215	6.09	62.9706	
"	2	2.125	9.115	6.99	78.5676	
"	3	2.125	8.915	6.79	74.9616	
"	4	2.125	9.135	7.01	78.9326	
"	5	2.125	8.125	6.00	61.5000	
"	6	2.125	7.695	5.57	54.6974	
"	7	2.125	7.795	5.67	56.2464	
3	8	2.125	7.115	4.99	46.1076	342,472.3500

10 CAN

Mile.	Furlong.	Half Bottom Breadth of Canal.	Half Top Breadth of Canal.	Depth of Excavation.	Area of Section.	Solid Feet every Mile.
		2.00	6.74	4.74	41.4276	
3	1	2.00	6.13	4.13	33.5769	
"	2	2.00	6.44	4.44	37.4736	
"	3	2.00	6.44	4.44	37.4736	
"	4	2.00	7.14	5.14	46.9796	
"	5	2.00	7.37	5.37	50.3169	
"	6	2.00	7.45	5.45	51.5025	
"	7	2.00	7.45	5.45	51.5025	
4	8	2.00	7.17	5.17	47.4089	233,140.9410
		1.50	6.67	5.17	42.2389	
"	1	1.50	6.31	4.81	37.5661	
"	2	1.50	6.15	4.65	35.5725	
"	3	1.50	6.03	4.53	34.1109	
"	4	1.50	6.06	4.56	34.4736	
"	5	1.50	6.19	4.69	36.0661	
"	6	1.50	6.25	4.75	36.8125	
"	7	1.50	6.48	4.98	39.7404	
5	8	1.50	6.51	5.01	40.1301	195,047.5560
		1.50	6.01	4.51	33.8701	
"	1	1.50	6.13	4.63	35.3269	
"	2	1.50	6.32	4.82	37.6924	
"	3	1.50	6.01	4.51	33.8701	
"	4	1.50	5.72	4.22	30.4684	
"	5	1.50	5.50	4.00	28.0000	
"	6	1.50	5.85	4.35	31.9725	
"	7	1.50	5.84	4.34	31.8556	
6	8	1.50	5.68	4.18	30.0124	172,343.9190
		1.50	5.18	3.68	24.5824	
	1	1.50	5.18	3.68	24.5824	
	2	1.50	5.23	3.73	25.1029	
	3	1.50	4.92	3.42	21.9564	
	4	1.50	4.47	2.97	17.7309	
	5	1.50	4.23	2.73	15.6429	
	6	1.50	4.22	2.72	15.5584	
	7	1.50	4.25	2.75	15.8125	
7	8	1.50	3.97	2.47	13.5109	102,585.813
		Mean half width	Probable mean.	Probable.		
8	..	1.50	4.50	3.00	18.0000	95,040.000
9	..	Probable. 1.50	Probable. 4.50	3.00	18.0000	95,040.000
10	..	Probable. 1.50	Probable. 4.50	3.00	18.0000	95,040.000
(Probable) Total solid feet excavation....						1,849,771.242

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.
		Rs. a. p.
1,849,771-242	Earthwork at Rs. 3 per 1,000 solid feet ..	5,549 5 0
	Total....Rs.	5,549 5 0
	Add—Contingencies at 5 per cent....	277 7 5
	Grand total....Rs.	5,826 12 5

In the original estimate for this branch canal the excavation was divided into three portions at the following rates, viz:—

1st portion, 1st and 2nd miles, rate Rs. 2-10-0 per 1,000 solid feet.

2nd „ 3rd and 6th miles „ Rs. 2-12-0 per do. do.

3rd „ 7th mile „ Rs. 2-8-0 per do. do.

But as far as the canal has gone (to the end of the 5th mile), the soil has turned out to be much harder than was expected, and it has been necessary to give the rate of Rs. 3 per 1,000 solid feet. The amount of the original estimate was Rs. 4,425. This shows a great probable excess, but it must be remembered that in this present estimate is included the probable extension of this branch for 3 miles.

REGULATING BRIDGE AT HEAD.

Where this branch takes off, a masonry and timber bridge has already been constructed across the Mitrow Canal, and this bridge will also be a masonry and timber one, connected with the above bridge by one of the up stream water wings and wing walls. There is to be one span of 9' 6", the abutments, water wings, and wing walls being the same as already described for these masonry and timber bridges, except that as the bed of this branch is 1' 6" above that of the main canal, the water wings will be only 6' 6" in height instead of 8 feet, and the abutments and wing walls will be also 1' 6" less in

height. The right bank up stream water wing will be joined on the left bank water wing of the canal bridge, and is to be 1' 6" thick at top and 6' 6" high. The right bank up stream water wing wall will also be connected with the left bank up stream water wing of the main bridge, the railings being also joined. On the right bank down stream side, instead of there being a separate water wing and wing wall, these two will be combined in one wall, which will be built up to the level of the top of the roadway, and this wall will be connected with the retaining wall of the approach between the two bridges, as shown in the drawing. On the left bank main canal, down stream side, the wing wall for 1 foot in height will have to be removed, and the water wing wall be altered in shape and raised in height to convert it into a water wing and wing wall combined similar to the opposite, and it also will be connected with the other retaining wall to the approach between the two bridges. This approach is 8' 6" wide and has a longitudinal slope of 1 in 15, the retaining wall being 39' long, after which the approach is continued with this longitudinal slope till it meets the existing spoil banks (3 feet in height), the side slopes being 1 to 1. The retaining walls are strengthened by 3 counterforts, each 1' 6" wide and 1 foot long, and on these walls are fixed the railings which are connected with the bridge railings. To prevent a scour, a pavement 1' 6" thick is provided, and a portion of it, 7 feet in length, immediately in rear of the gate sill, is 3 feet thick. The pavement extends from 6 feet in front of the gate sill to 21 feet in rear of it, and is supported in rear by a rear curtain wall 3 feet deep, 1' 6" thick at top, and 2 feet at bottom, it being built in 3 steps of 1 foot each. The gate sill is also 3 feet deep, and built in 3 steps of 1 foot each, it being 2 feet thick at top and 2' 6" at bottom. The regulating apparatus consists of horizontal babool wales, with filling pieces, and teak wood baulks (vertical) and straining pieces. The babool wales are 8' $\times$ 7" and let 4" into the masonry on each side, the straining pieces are 3" $\times$ 6" and the baulks 5" $\times$ 5". The approach left bank to have a longitudinal slope of 1 in 15 and side slopes of $1\frac{1}{2}$ to 1.

CONSTRUCTION.

The whole of the masonry to be of the best burnt brick and lime, the pavement and upper courses of the water wings being brick on

edge. The roadway of the bridge to be carried on a timber superstructure as follows, viz., 3 babool beams 11' $\times$ 1' $\times$ 1' resting on wall plates 13' $\times$ 1' $\times$ 1'; above these beams transverse baulks 5" $\times$ 5" of deodar wood, and above these kirul rafters and mats, above which will come the earth filling in. The railings to be of deodar wood; all the babool and deodar wood to be well dammered.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Abutments	2	13-0	5-5	3-00	429-00	
Water wings	3	11-28	3-0	3-00	304-56	
Water wing and wing wall combined	1	15-50	4-0	3-00	186-00	
Wing walls, left bank	2	5-75	2-0	2-00	46-00	
Do. right bank	1	1-50	2-0	2-00	6-00	
		Mean.				
Pavement in front of gate sill	1	11-5	6-0	1-5	103-50	
Gate sill	1	8-0	2-5	3-0	60-00	
Pavement	1	16-5	8-0	1-5	198-00	
Do. portion	1	6-5	8-0	1-5	178-00	
Rear curtain wall	1	10-25	2-0	3-0	61-50	
Retaining walls to approach (portion)	2	11-5	3-5	8-32	669-76	
Do. do. do.	2	9-0	3-00	5-32	287-28	
Do. do. do.	2	9-0	2-75	2-50	123-75	
Do. do. do.	2	9-5	2-50	1-50	71-25	
Counterforts to do.	2	1-0	1-5	8-32	24-96	
Do. do. do.	2	1-0	1-5	5-32	15-96	
Do. do. do.	2	1-0	1-5	1-50	4-50	2,670-020
<i>Deduct.</i>						
Portion of water wing down stream (left bank of main canal)	1.	6-0	3-0	3-0	54-00	
Total solid feet excavating foundation....						2,616-02

N.B.—To avoid confusion in the plan, this water wing has not been shown in black ink.

*Filling in Foundation, Burnt
Brick and Lime.*

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	13-0	5-25	3-0	409-50	
Water wings	3	11-28	2-75	3-0	279-18	
Water wing and wing wall combined	1	15-50	3-75	3-0	174-375	
Wing walls, left bank	2	5-75	1-75	2-0	40-250	
Do. right do.	1	1-50	1-75	2-0	5-250	
Pavement in front of gate sill ..	1	12-0	6-0	1-5	108-000	
Gate sill	1	8-5	2-25	3-0	57-375	
Pavement	1	17-0	8-5	1-5	216-750	
Do. portion	1	6-75	8-5	1-5	86-0,625	
Rear curtain wall	1	10-75	1-75	3-0	56-4,375	
Retaining walls to approach..	2	11-5	3-5	8-32	669-76	
Do. do.	2	9-0	3-0	5-32	287-28	
Do. do.	2	9-0	2-75	2-50	123-75	
Do. do.	2	9-5	2-50	1-50	71-25	
Counterforts to do.	2	1-0	1-50	8-32	24-960	
Do. do.	2	1-0	1-50	5-32	15-960	
Do. do.	2	1-0	1-50	1-50	4-500	2,630-64
<i>Deduct.</i>						
Portion of water wing down stream left bank of canal ..	1	6-0	3-75	3-0	49-50	49-50

Total solid feet filling in plinth, burnt brick and lime.... 2,581-14

*Superstructure, Burnt Brick
and Lime.*

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	13-0	Mean. 3-0	12-5	975-00	
Water wings	3	11-28	Mean. 1-75	6-5	384-93	
Water wing and wing wall, combined portion	1	15-50	3-0	2-83	131-13	
Wing walls left bank	2	7-75	1-5	6-5	151-125	
Do. right do.	1	3-50	1-5	6-5	34-125	
Retaining walls to approaches.	2	39-0	2-25	2-5	438-750	
Do. do. do. ..	2	39-0	2-00	1-5	234-000	
Do. do. do. ..	2	39-0	1-75	1-5	204-750	
Do. do. do. ..	2	39-0	1-50	26-8 2	156-780	
Carried over solid feet..	..	..	..	..	....	2,710-59

<i>Superstructure, Burnt Brick and Lime—(continued).</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Brought over solid feet..	..	..	..	..	....	2,710.59
Counterforts to approaches (up to coping)	2	1.0	1.5	11.18	33.540	
Do. do. do. ..	2	1.0	1.5	9.84	29.520	
Do. do. do. ..	2	1.0	1.5	8.5	25.500	
Pillars to water wing and wing wall combined and retaining walls to approach	12	1.5	1.5	3.0	81.000	
Water wing and wing wall combined (portion)	2	15.5	2.75	5.0	427.250	
Do. do. do. ..	2	15.5	2.25	3.0	209.250	951.45
Do. do. do. ..	2	15.5	1.75	2.68	145.390	3,662.04
<i>Deduct.</i>						
Portion of water wing down stream left bank of main canal	1	6.0	1.75	8.0	84.00	84.00
Total solid feet superstructure burnt brick and lime....						3,578.04

<i>Coping 9 inches with Burnt Brick and Lime.</i>	N.	L.	Running Feet.
Pillars, including counterforts	6	2.5	15.00
Do. remainder.....	6	1.5	9.00
Total running feet coping....			24.00

<i>Babool Wood.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Wall plates.....	2	13.0	1.0	1.0	26.000	
Corbels	6	2.5	0.75	0.75	8.437	
Beams	3	11.0	1.0	1.0	33.000	
Walls horizontal	4	10.16	0.66	0.583	15.815	
Filling in pieces (vertical)....	2	6.5	0.66	0.33	2.888	
Total solid feet babool wood....						86.140

Deodar Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Baulks.....	2	13·0	0·416	0·416	4·514	
Do.	2	11·0	0·416	0·416	3·819	
Up stream side, including both wing walls (top).....	1	26·0	0·416	0·416	4·514	
Do. do. do. (middle) ..	1	26·0	0·33	0·33	2·888	
Down do. do. (upright) ..	4	3·0	0·33	0·33	1·333	
Do. do. do. one wing wall (top)	1	20·0	0·416	0·416	3·472	
Do. do. do. (middle) ..	1	20·0	0·33	0·33	2·222	
Do. do. do. (upright) ..	4	3·0	0·33	0·33	1·333	
Struts, both sides	2	2·5	0·25	0·16	0·277	
Waterwing and wing wall combined (top)	2	15·5	0·416	0·416	5·382	
Do. do. do. (middle) ..	2	15·5	0·33	0·33	3·444	
Top rail to approach	2	38·0	0·416	0·416	13·194	
Middle do. do.	2	38·0	0·33	0·33	8·444	
Side planks to retain roadway.	2	10·5	1·00	0·16	3·500	
Total solid feet deodar wood....						58·336

<i>Roadway Kirul Rafters and Grass Mats.</i>	N.	L.	B.	Square Feet.	Total Sq. Feet.
Overbridge	1	9·5	8·0	7·600	
Total square feet roadway kirul rafters, &c.....					76·00

<i>Earthwork, Filling in.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Roadway over bridge ..	1	9·5	8·0	1·0	76·000	
Between wing walls, left bank	1	7·0	10·00	8·18	572·600	
Do. do. right do.	1	7·0	Mean. 5·0	8·18	286·300	
Do. water wings and wing walls combined..	1	14·0	Mean. 22·5	8·18	2,576·700	
Approach, left bank	1	122·70	Mean. 21·18	$\frac{8·18}{2}$	10,629·034	
Do. right do. between retaining walls	1	39·0	Mean. 8·5	6·88	2,280·620	
Do. do. do. remainder (on spoil banks)	1	38·70	Mean. 10·22	2·58	510·213	
Total solid feet earthwork filling in						16,931·467

Teak Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Vertical baulks	23	6.5	0.416	0.416	25.955	
Straining pieces	2	6.5	0.50	0.25	1.625	
Guage, upper.....	1	6.5	0.33	0.16	0.361	
Do. lower.....	1	6.5	0.33	0.16	0.361	
Total solid feet teak wood....						28.302

Screws, Iron (2' 10" long).

	Number.
Screws to bridge	6
Total number of screws to bridge....	6

ABSTRACT.

Quantities or Number.	Description of Work, and Rate.	Amount.
		Rs. a. p.
2,616.02 solid feet.	Excavating foundation at Rs. 0-12-0 per 100 solid feet.....	19 9 11
2,581.14 " "	Filling in do. burnt brick and lime, at Rs. 23 per do	593 10 11
3,578.04 " "	Superstructure do. at Rs. 25 per do.....	894 8 2
24.00 sq. feet.	Coping, at Rs. 0-8-0 per solid foot.....	12 0 0
86.14 solid,,	Babool wood, at Rs. 7-8 per sd.ft. } including .	129 3 4
58.336 " "	Deodar wood, at Rs. 2 per do. } dammering	116 10 9
76.000 sq. feet.	Roadway kirul rafters and grass mats, at Rs. 3-12-0 per 100 square feet	9 1 11
16,931.467 solid feet.	Earthwork filling in at Rs. 3-8-0 per 1,000 solid feet.....	59 3 4
28.302 " "	Teak wood, at Rs. 4-4-0 per solid foot....	120 4 6
6 numbers.	Screws, iron, 2' 10" long, at Rs. 1 per each.	6 0 0
Total....Rs		1,960 4 10
Add—contingencies at 5 per cent.		98 0 3
Grand total....Rs		2,058 5 1

ROAD BRIDGES, 4TH MILE.

This bridge to be built in the 4th furlong of this mile, where the bottom breadth of the branch is 4 feet, depth of water 4 feet, and depth of excavation 5·14 feet; a waterway of 8 feet is required, which will be in one span, the rise of arch being 2 feet and thickness 1 foot, the springing line being 6 feet above the bed of the branch. The abutments to be 3 feet thick, with foundations 3 feet deep built in 2 steps of 1' 6" each, with an offset of 3" on each side at each step, the abutment being 4 feet thick at foundation level. Wing walls are provided, the foundation being on the level of the bed of the canal. They are 2' 6" thick at foundation, and built in steps, as shown in plan. They terminate in newels 2 feet square. The roadway over the bridge to be 10' 6" between the parapets. The approaches to be 20 feet wide with a rise of 1 in 15, and side slopes of $1\frac{1}{2}$ to 1.

CONSTRUCTION.

The whole of the masonry to be of the best burnt brick and lime.

Measurements.

<i>Excavating Foundation.</i>	N.	L.	B.	D.	Solid feet.	Total Solid Feet.
Abutments, including pilasters	2	14·5	4·0	3·0	348·00	
Wing walls.....	4	11·75	2·5	5·14	603·95	
Newels to do.....	4	2·0	3·5	5·14	143·92	
Total solid feet excavating foundation....						1,095·87

<i>Filling in Foundation, Burnt Brick and Lime.</i>	No.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters	2	14·5	3·75	3·0	326·25	
Wing walls.....	2	11·75	2·25	6·0	634·50	
Newels to do.	4	2·0	3·25	6·0	156·00	
Total solid feet filling in foundation, burnt brick and lime....						1,116·75

<i>Superstructure, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, excluding pilasters	2	12.5	3.0	6.0	450.00	
Skew Backs	2	2.75	12.5	0.5	34.375	
		Area.				
Backing	2	3.75		12.5	93.75	
		Area.				
Spandril walls.....	4	6.125		1.5	36.75	
Wingwalls	4	11.75	1.75	3.0	246.75	
Newels	4	2.0	2.75	3.0	66.00	
Face walls	2	37.5	1.25	1.0	93.75	
Newels	4	2.0	2.25	1.0	18.00	
Parapet walls	2	57.5	1.00	1.5	112.50	
Newels.....	4	2.0	2.0	1.5	24.00	
Pilasters to abutments up to parapet (calculated square to allow for extra trouble)..	4	3.0	1.0	11.6	138.00	
Total solid feet superstructure, burnt brick and lime....						1,313.875

<i>Archwork, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
		Mean.				
Arch	1	10.203	12.5	1.0	127.537	
Total solid feet archwork, burnt brick and lime....						127.537

<i>String Course, 1st sort.</i>	N.	L.	Running Feet.	Total Running Feet.
To face walls, including pilasters & newels..	2	44.5	89.00	
Total running feet string course, 1st sort....				89.00

<i>Coping, Burnt Brick and Lime.</i>	N.	L.	Running Feet.	Total Running Feet.
Parapet walls	2	37.5	75.000	
Pilasters	4	3.0	12.000	
Newels	4	2.0	8.000	
Total running feet coping burnt brick and lime....				95.000

<i>Earthwork.</i>						Total	
	N.	L.	B.	D.	Solid Feet.	Solid Feet.	
Filling in between spandril walls	2	Area. 6.125		9.5	116.375		
Do. wing walls ...	2	Mean. 10.0	13.375	4.86	1,300.050		
Roadway overbridge.....	1	14.0	10.0	1.00	140.00		
Approaches	2	Mean. 72.90	24.86	$\frac{4.86}{2}$	3,807.748		
Total solid feet earthwork....						10,364.173	

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.		
		Rs.	a.	p.
1,095.87 solid feet	Excavating foundation at Rs. 0-12-0 per 100 solid feet	8	3	6
1,116.75 „ ..	Filling in foundation burnt brick and lime at Rs. 23 do.....	256	13	8
1,313.875 „ ..	Superstructure do. do. at Rs. 25 do ..	328	7	6
127.537 „ ..	Archwork do. do. at Rs. 32-8-0 do. ..	41	7	4
89.00 rg. feet.	String course, 1st sort, at Rs. 15 per rg. ft..	13	5	7
95.00 „ ..	Coping, at Rs. 0-8-0 per running foot	47	8	0
10,364.173 sd. feet.	Earthwork, at Rs. 3-8-0 per 100 solid feet..	36	6	0
Total.... Rupees		732	3	7
Add—Contingencies at 5 per cent....		36	9	9
Grand total.... Rupees		768	13	4

Tail Sluice Bridge.

This bridge is to be built in the 7th mile, near where the roads from Ramjagah and Gorchancee to Samara meet each other. The width of the canal at this point is 3 feet, depth of water 3 feet, and depth of excavation 2' 9". With the sluice is connected a road bridge 12' 6" wide between the parapets. There is one span 6 feet wide, the arch springing at a height of 5 feet from the bed of the branch,

the rise being 1' 6" and thickness of arching 1 foot. Water wings are provided, the up stream ones being 5 feet above the bed of the branch, 2' 6" thick at foundation, and 1' 6" at top. The down stream ones are 4 feet high, 2' thick at foundation, and 1 foot thick at top. The abutments are 2' 6" thick with foundations 3' 6" thick. The foundations of the abutments and water wings are 3 feet below the bed of the canal, and those of the wing walls on the level of the bed when these walls are 2' 6" thick, being built in steps, as shown in the drawings. The arrangement of the pavement, and gate sill, and rear curtain wall is very similar to that already described for the regulating bridge at the head, while for the regulating apparatus there is the same system of horizontal babool wales and vertical teak baulks. The approaches to have a rise of 1 in 15 and side slopes of $1\frac{1}{2}$ to 1.

Construction.

The whole of the masonry to be of the best burnt brick and lime.

MEASUREMENTS.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Abutments, including pilasters.	2	17.5	3.5	3.0	367.500	
Waterwings up stream	2	8.0	2.5	3.0	120.000	
Do. down do.	2	8.0	2.0	3.0	96.000	
Returns to do. up stream	2	2.0	1.25	3.0	15.00	
Do. do. down do.	2	2.5	1.25	3.0	18.75	
Wing walls	4	11.0	2.5	2.75	302.500	
Newels to do.	4	2.0	3.5	2.75	77.000	
			Mean.			
Pavement in front of gate sill.	1	5.0	6.25	1.5	46.875	
Gate sill	1	5.0	2.25	3.0	33.75	
Pavement from gate sill to end of pilasters	1	15.25	5.0	1.5	114.375	
Do. do. do. portion (3 feet thick)	1	7.0	5.0	1.5	62.50	
			Mean.			
Pavement to rear curtain wall.	1	3.75	5.50	1.5	30.9375	
Rear curtain wall	1	6.75	1.75	3.0	35.4375	
Total solid feet excavating foundation....						1,310.625

<i>Filling in Foundation, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters.	2	17.5	3.0	2.0	315.00	
Water wings up stream.....	2	8.0	2.375	3.0	114.00	
Do. down stream....	2	8.0	1.875	3.0	90.00	
Returns to do. up stream....	2	2.0	1.25	3.0	15.00	
Do. do. down do.	2	2.5	1.25	3.0	18.75	
Wing walls	4	11.0	2.375	3.0	313.50	
Newels to do.....	4	2.0	3.375	3.0	81.00	
Pavement in front of gate sill.	1	5.0	6.75	1.5	50.625	
Gate sill	1	5.25	2.125	3.0	33.468	
Pavement from gate sill to end of pilasters	1	15.50	5.50	1.5	127.875	
Do. do. portion (3 feet thick)	1	7.25	5.50	1.5	59.8124	
Pavement to rear curtain wall.	1	4.00	6.125	1.5	36.7500	
Rear curtain wall	1	7.375	1.875	3.0	13.828	

Total solid feet filling in foundation, burnt brick and lime.... 1,269.608

<i>Superstructure, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters (down stream)	2	16.5	2.5	5.0	412.50	
Skew backs	2	2.25	14.5	0.5	32.625	
Backing ..	2	14.5	Area 3.25		94.250	
Spandril walls	4	1.5	Area 3	4.375	20.625	
Water wings up stream	2	8.0	1.625	5.0	130.000	
Returns to do. do.	2	2.375	1.25	5.0	29.687	
Water wings down stream ..	2	8.00	1.125	4.0	72.000	
Returns to do. do.	2	2.875	1.25	4.0	28.75	
Wing walls	4	11.0	1.75	4.5	346.50	
Newels to do.	4	2.0	2.75	4.5	99.00	
Face walls	2	33.0	7.25	1.0	82.50	
Newels	4	2.0	2.25	1.0	18.00	
Parapet walls	2	33.0	1.00	1.5	99.00	
Newels	4	2.0	2.00	1.5	24.00	
Pilasters up to coping (up stream)	2	2.5	1.00	5.00	25.00	
Do. do. do. down stream.....	2	2.5	1.00	6.00	30.00	

Total solid feet superstructure, burnt brick and lime.... 544.4371

N.B.—The pilasters have been calculated square to make allowance for the extra trouble in shaping the bricks.

Archwork, Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Arch	1	7.882	14.6	1.0	112.318	

Total solid feet archwork burnt brick and lime.... 112.318

String Course, 1st sort.

	N.	L.	Running Feet.	Total Running Feet.
To face walls including pilasters and newels....	2	42.00	84.00	

Total solid feet string course, 1st sort.... 84.00

Coping.

	N.	L.	Running Feet.	Total Running feet.
To parapet walls.....	2	33.00	66.00	
Pilasters	4	2.50	10.00	
Newels	4	2.00	8.00	

Total running feet coping.... 84.00

Babool Wood.

	N.	L.	B.	D.	Solid feet.	Total Solid Feet.
Walls	3	6.66	0.66	0.5	6.666	
Filling in pieces.....	2	5.00	0.66	0.33	2.222	

Total solid feet babool wood.... 8.888

Teak Wood.

	N.	L.	B.	D.	Solid feet.	Total Solid Feet.
Vertical baulks	18	6.5	0.33	0.33	13.000	
Straining pieces.....	2	6.5	0.5	0.25	1.625	
Gauges up and down stream (5 feet x 4 feet)	1	9.0	0.33	0.66	2.000	

Total solid feet teak wood.... 16.625

	No.	L.	B.	D.	Solid Feet.	Total Solid Feet.
<i>Earthwork.</i>						
Between spandril walls ..	2	11.5	Area. 3.4375		79.062	
Do. wing walls	2	10.0	Mean. 14.75	5.75	1,696.2500	
Roadway over bridge ..	1	11.0	12.00	1.00	132.0000	
Approaches	2	86.25	Mean. 25.75	$\frac{5.75}{2}$	12,775.390	
Total solid feet earthwork....						14,582.702

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.
1,310.625 sd. feet.	Excavating foundation, at Rs. 0-12-0 per 100 solid feet	Rs. a. p. 9 13 3
1,269.608 „ ..	Filling in do. burnt brick and lime, at Rs. 23 per do.	292 0 2
1,544.437 „ ..	Superstructure do. at Rs. 25 per do.	386 1 9
112.318 „ ..	Archwork do. at Rs. 32-8-0 per do.	36 8 1
84.000 rg. feet.	String course, 1st sort, at Rs. 15 per rg. feet.	12 9 7
84.000 „ ..	Coping, at Rs. 0-8-0 per running foot.....	42 0 0
8.888 sd. feet.	Babool wood, at Rs. 1-8-0 per solid foot ..	13 5 4
15.695 „ ..	Teak wood, at Rs. 4-4-0 per do.	70 10 6
14,682.702 „ ..	Earthwork, at Rs. 3-8-0 per 100 solid feet..	51 6 3
Total Rs.		914 6 11
Add—Contingencies at 5 per cent....		45 11 7
Grand total....Rupees		960 2 6

SAMARA BRANCH—RECAPITULATION.

	Rs. a. p.
Excavating branch	5,826 12 5
Regulating bridge at head	2,058 5 1
Road bridge on 4th mile	768 13 4
Tail sluice	960 2 6
Grand Total....Rs.	9,614 1 4

DURRAILA BRANCH.

General Description.

This branch leaves the Mitrow Canal in the 3rd furlong of the 79th mile, about 2 miles from the village of Churr, and passes at the tail close to the village of Durraila, where there is a Police Thana. The length of the branch is 4 miles, 5 furlongs, and 316 feet, and it tails off into a large dund connected with a Dhora, which, starting from the Narra, passes Ramoolhur and goes in a southerly direction. This branch is to throw water into this dund for cultivation, as well as to irrigate the land to the east. The bottom breadth is 4 feet, and depth of water in it also 4 feet, the sideslopes being $1\frac{1}{2}$ to 1, and these dimensions are maintained the same throughout the whole length. The bed of the branch has a longitudinal slope or fall of 8" per mile. The spoil to be thrown up, so as to have a clear space of 5 feet each side between the foot of the spoil and edge of excavation.

MEASUREMENTS.

	Half Top Breadth.	Half Bottom Breadth.	Depth of Exca- vation.	Area of Section.	Solid Feet per Mile.	Total Solid Feet.
Peg at Head	2-00	7-625	3-75	36-09375		
1st mile, 1st furlong . .	2-00	7-535	3-69	35-18415		
2nd " . .	2-00	7-430	3-62	34-13360		
3rd " . .	2-00	7-550	3-70	35-33500		
4th " . .	2-00	6-920	3-28	29-25760		
5th " . .	2-00	7-865	3-91	38-57215		
6th " . .	2-00	8-135	4-09	41-45215		
7th " . .	2-00	8-285	4-19	43-09415		
8th " . .	2-00	9-290	4-86	54-86940	199,659-8275	
2nd mile, 1st " . .	2-00	9-485	4-99	57-31015		
2nd " . .	2-00	10-100	5-40	65-34000		
3rd " . .	2-00	10-250	5-50	67-37500		
4th " . .	2-00	9-965	5-31	63-53415		
5th " . .	2-00	10-085	5-39	65-13815		
6th " . .	2-00	10-565	5-71	71-74615		
7th " . .	2-00	10-400	5-60	69-44000		
8th " . .	2-00	10-130	5-42	65-74460	343,325-7960	

MEASUREMENTS—(continued).

	Half Top Breadth.	Half Bottom Breadth.	Depth of Exca- vation.	Area of Section.	Solid Feet per Mile.	Total Solid Feet.
3rd mile, 1st furlong .	2.00	9.830	5.42	61.75260	295176.5685	
2nd " ..	2.00	9.665	5.11	59.60815		
3rd " ..	2.00	9.290	4.86	54.86940		
4th " ..	2.00	9.245	4.83	54.31335		
5th " ..	2.00	9.245	4.83	54.31335		
6th " ..	2.00	9.200	4.80	53.76000		
7th " ..	2.00	9.140	4.76	53.02640		
8th " ..	2.00	8.495	4.33	45.44335		
4th mile, 1st " ..	2.00	7.970	3.98	39.68060	189,198.9990	
2nd " ..	2.00	7.445	3.63	34.28535		
3rd " ..	2.00	7.670	3.78	36.55260		
4th " ..	2.00	7.445	3.63	34.28535		
5th " ..	2.00	7.445	3.63	34.28535		
6th " ..	2.00	7.775	3.85	37.63375		
7th " ..	2.00	7.040	3.36	30.37440		
8th " ..	2.00	7.385	3.59	33.69215		
5th mile 1st " ..	2.00	7.070	3.38	30.65660	96278.8695	
2nd " ..	2.00	7.325	3.55	33.10375		
3rd " ..	2.00	7.295	3.53	32.81135		
4th " ..	2.00	6.830	3.22	28.43260		
5th " ..	2.00	4.01	1.34	8.05340		
				8.05340		
End portion triangular length 316 feet				2	1,272.4372	1,124,911.4977
Total solid feet excavation....						1,124,911.4977

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.
1,124,911.4977 Sd. ft..	Excavation, including ramming and levelling, at Rupees 3-12-0 per 100 solid feet	4,218 6 7
Total....Rs.		4,218 6 7
Add—Contingencies at 5 per cent....		210 14 9
Grand total....Rs.		4,429 5 4

REGULATING BRIDGE AT HEAD.

This bridge to consist of one span of 10 feet, with a rise of 2 feet, and thickness of arching 1 foot, the springing line being 6 feet above the bed of the branch, which latter is 2 feet above that of the main canal at this point. Water wings up and down stream are provided, the up stream ones being 2 feet thick at top, 3' 9" at foundation, and 6 feet above the bed of the branch, while the down stream ones are 1' 6" thick at top, 3 feet at foundation, and are 4 feet high. The up stream water wing right bank is to be joined to the up stream water wing left bank of the 79th mile bridge Mitrow Canal, and these bridges will still further be connected by the up stream inner wing walls. The abutments are 3' 6" thick, while their foundations are 5' 6" thick. The foundations of abutments and water wings are 6 feet deep, built in 4 steps of 1' 6" each, with an off set of 3" each side each step. The foundations of the wing walls are on the level of the bed of the branch, and they are here 3' 6" thick, and are built in steps, as shown in the drawings. The retaining to the steps has its foundation 4 feet below the ground line and is 2' 6" thick. The arrangement of the pavement is very similar to that described in the 79th mile bridge, and the regulating apparatus is also similar, consisting of horizontal babool wales and vertical teak baulks. The approaches to have a rise of 1 in 15 and side slopes of $1\frac{1}{2}$ to 1.

CONSTRUCTION.

All the masonry to be of best burnt brick and lime.

MEASUREMENTS.

	N.	L.	B. •	D.	Solid Feet.	Total Solid Feet.
<i>Excavating Foundation.</i>						
Abutments, including pilasters	2	15.0	5.5	6	990.00	
Up stream water wing, right bank	1	20.00	3.75	6	450.00	
Do. do. left do. ...	1	12.50	3.75	6	281.25	
Down stream water wings....	2	12.50	3.0	6	450.00	
Wing walls.....	3	16.50	3.5	6	1,039.50	
Up stream wing wall, right bank	1	12.50	3.5	6	262.50	
Steps	1	6.0	3.0	2.0	36.00	

*Excavating Foundation—
(continued).*

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Retaining wall to right bank .	1	7.5	2.5	4.0	75.00	
Pilasters to do.	1	2.0	1.0	4.0	8.00	
Returns to water wings.....	2	2.75	1.25	6.0	20.625	
Do. do.	2	3.25	1.25	6.0	48.750	
Newels to wing walls	3	3.25	2.75	6.0	160.875	
			Mean			
Pavement in front of gate sill .	1	8.00	9.75	1.5	117.000	
Gate sill.....	1	8.00	2.75	6.	132.000	
Pavement as far as end of abutments	1	12.25	8.0	1.5	147.00	
Do. portion (3 feet thick).	1	5.25	8.0	1.5	63.00	
Pavement up to rear curtain wall.....	1	6.75	9.25	6.0	374.625	
Rear curtain wall	1	11.5	2.25	6.0	155.250	

Total solid feet excavating foundation.... 4,811.375

*Filling in Foundation, Burnt
Brick and Lime.*

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	15.0	4.75	6	855.00	
Up stream water wing, right bank	1	20.00	3.375	6	405.00	
Do. do. left do.	1	12.50	3.375	6	253.125	
Down stream water wings....	2	12.50	2.875	6	431.250	
Wing walls.....	3	16.5	3.00	6	891.000	
Up stream wing wall, right bank	1	12.5	3.00	6	225.000	
Steps	1	6.0	3.25	2	39.000	
Retaining wall to do.	1	7.5	2.375	4	71.250	
Pilasters to do.	1	2.0	1.0	4	8.000	
Returns to water wings.....	2	3.125	1.25	6	23.4375	
Do. do.	2	3.625	1.25	6	54.375	
Newels to wing walls.....	3	3.00	2.50	6	135.00	
Pavement in front of gate sill	1	8.00	11.25	6	540.00	
Gate sill	1	8.75	2.375	6	124.6875	
Pavement as far as end of abutment	1	13.00	9.5	1.5	185.2500	
Do. portion (3 feet thick)	1	5.75	9.0	1.5	77.6250	
Pavement up to rear curtain wall	1	7.50	11.0	1.5	123.7500	
Rear curtain wall	1	13.5	1.875	6.0	151.8750	

Total solid feet foundation, burnt brick and lime.... 4,594.625

*Superstructure, Burnt
Brick and Lime.*

	No.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	15.0	3.5	6	630.00	
Up stream water wing,						
right bank	1	20.0	2.25	6	270.00	
Do. do. left bank ..	1	12.5	2.25	6	168.75	
Down stream water wings	2	12.5	1.625	4	162.50	
Wing walls (portion)....	3	16.5	2.0	2.0	198.00	
Do. do.	3	16.5	1.75	1.75	151.5937	
Do. do.	3	16.5	1.50	1.25	92.8125	
Up stream wing wall,						
right bank (portion) ..	1	12.5	2.0	2.0	50.0000	
Do. do. (do.) ..	1	12.5	1.75	1.75	38.28125	
Do. do. (do.) ..	1	12.5	1.50	1.25	23.4375	
Steps	1	6.0	3.5	4.0	84.0000	
Retaining wall to do.						
(portion)	1	7.5	2.0	1.5	22.5000	
Do. do. (do.) ..	1	7.5	7.95	1.83	24.0625	
Do. do. (do.) ..	1	7.5	1.375	2.66	27.5000	
Landing	1	2.5	4.0	1.5	15.0000	
Parapet wall to retaining						
wall	1	7.5	1.0	2.0	15.0000	
Pilaster to do. up to						
coping	1	2.0	1.0	8.0	16.0000	
Returns to water wing ..	1	2.75	1.25	6.0	20.6250	
Do. do.	2	3.25	1.25	4.0	32.5000	
Newels to wing walls (por-						
tion)	3	2.50	3.00	2.0	45.0000	
Do. do. (do.) ..	3	2.25	2.75	1.75	32.5093	
Do. do. (do.) ..	3	2.50	2.00	1.75	18.7500	
Face walls (up stream 46,						
down stream 50)	1	96.0	1.25	1.0	120.0000	
Do. do. newels	3	2.25	1.75	1.0	11.8125	
Pilasters to abutments,						
up stream	2	2.5	2.5	6.0	30.0000	
Do. do. down do.	2	2.5	2.5	8.0	40.0000	
Skew backs	2	12.00	12.00	0.75	54.0000	
Backing	2	12.00	5.25	..	126.000	
Spandril walls	2	1.5	5.3125	..	15.9375	
Parapet walls (up stream						
44, down do. 50) ..	1	94.0	1.0	2.0	188.0000	
Do. do. newels ..	3	2.0	1.0	2.0	18.0000	

Total solid feet superstructure.... 2,742.5718

N. B.—In the above item the pilasters have been calculated as square, to make allowance for the extra trouble in cutting the bricks to the proper shape.

Arch work, Burnt Brick and Lime.

	N.	L.	B.	D.	Solid Feet.
Arch	1	12·553	12	1	150·636
Total solid feet arch work, burnt brick and lime....					150·636

String Course.

	N.	L.	Running Feet.
Face wall, up stream, including pilasters and newels.....	1	49·25	49·25
Do. do. down do. do.	1	53·25	53·25
Retaining wall to steps, including pilasters	1	9·50	9·50
Total running feet string course....			112·00

Coping.

	N.	L.	Running Feet.
Parapet wall, up stream	1	46·00	46·000
Do. down do.	1	50·00*	50·000
Pilasters to abutments.....	4	2·50	10·000
Newels to wing walls	3	2·00	6·000
Retaining walls to steps	1	7·50	7·500
Newels to do. do:	1	2·00	2·000
Total running feet coping....			121·50

Babool Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Wales	4	10.66	0.66	0.583	16,592	
Filling in pieces	2	6.00	0.66	0.583	2,666	
Total solid feet babool wood....						19,258

Teak Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Vertical baulks	24	7.5	0.416	0.416	31,250	
Straining pieces	2	6.0	0.50	0.25	1.50	
Guages (up stream 6' down 4')	1	10.0	0.33	0.76	0.555	
Total solid feet teak wood.....						35,305

N. B.—All the measurements for this bridge have been calculated up to the line shown in plan, dividing it from the 79th mile bridge main canal, hence only half the approach on the right bank is shown.

Earthwork.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Between spandril walls	2	9.0	Area. 5.3125		95.625	
	1	17.0	9.5	1.0	167.500	
Roadway over bridge			Mean.			
Between wing walls, left bank.	1	15.0	8.75	6.0	787.500	
			Mean.			
Do. do. right do.	1	11.0	14.25	6.0	940.500	
			Mean.			
Do. do. do. portion.	1	20.5	4.5	6.0	553.000	
			Mean.	Mean.		
Approach, left bank	1	90.0	26.00	3.00	7,020.000	
			Mean.			
Half do. right do.	1	90.0	10.00	3.00	2,700.000	
Total solid feet earthwork....						12,258.625

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.		
		Rs.	a.	p.
4,811·375 solid feet	Excavating foundation at Rs. 0-12-0 per 100 solid feet			
4,594·625 " "	Filling in do. burnt brick and lime, at Rs. 23 per do. do.	1,056	12	3
2,742·5718 " "	Superstructure do. do. at Rs. 25 do.	685	10	3
150·636 " "	Archwork do. do. at Rs. 32-8-0 per do.	48	15	4
112·000 rg. feet.	String course at Rs. 15 per 100 running feet	16	12	10
121·50 " "	Coping at Rs. 0-8-0 per running foot.....	60	12	0
19·258 solid feet.	Babool wood at Rs. 1-8-0 per solid foot ..	28	14	2
33·305 " "	Teak wood at Rs. 4-4-0 per do.	147	8	9
12,258·625 " "	Earthwork at Rs. 3-8-0 per 100 solid feet.	42	14	6
Total....Rs.		2,118	5	5
Add—Contingencies at 5 per cent....		105	14	8
Grand total...Rs.		2,224	4	1

Road Bridge in 3rd Mile.

This bridge to be constructed in the 3rd furlong of this mile, where the depth of excavation is 4·86 feet. There is to be one span of 10 feet, with rise of 2' 6" and thickness of arch ring 1 foot, the arch springing at 6 feet above the bed of the canal, or 2 feet above ordinary water line. The abutments to be 3' 6" thick, their foundations being 4 feet deep, built in 2 steps of 2 feet each, with an offset of 3" on each side at each step, the abutments are therefore 4' 6" thick at bed of foundation. The foundations of the wing walls are on the level of the bed of the canal, and here they are 2' 9" thick, being built in steps as shown in drawing. The bridge to be 10' 6" wide between the parapets. The approaches to have a rise of 1 in 15, and side slopes of $1\frac{1}{2}$ to 1 and to be 20 feet wide.

CONSTRUCTION.

The whole of the masonry to be of the best burnt brick and lime.

MEASUREMENTS.

<i>Excavating Foundation.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters	2	14.5	4.5	4.0	522.00	
Wing walls.....	4	11.75	2.75	4.86	628.755	
Newels to do.....	4	2.0	3.75	4.86	145.800	

Total solid feet excavating foundation.... 1,295.955

<i>Filling in Foundation, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters	2	14.5	4.25	4	493.00	
Wing walls (up to springing line).....	4	11.75	2.50	6	705.00	
Newels to do.....	4	2.00	3.50	6	168.00	

Total solid feet filling in foundation burnt brick and lime.... 1,366.00

<i>Superstructure, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments (excluding pilasters).....	2	12.5	3.5	6.0	525.000	
Skew backs	2	3.25	12.5	0.5	40.625	
Backing	2	12.5	Area	6.00	150.000	
Spandril walls*	4	1.5	Area	8.5	51.000	
Wing walls (portion).....	4	11.75	2.0	1.5	141.000	
Do. do. (do.).....	4	11.75	1.625	2.0	152.750	
Newels (portion)	4	2.0	3.0	1.5	36.000	
Do. (do.)	4	2.0	2.625	2.0	42.000	
Face walls	2	40.5	1.25	1.0	101.250	
Newels	4	2.0	2.25	1.0	18.000	
Parapet wall	2	40.5	1.0	1.5	129.500	
Newels	4	2.0	2.0	1.5	24.000	
Pilasters up to coping	4	2.5	1.0	12.0	120.000	

Total solid feet superstructure, burnt brick and lime.... 1,523.125

N.B.—The pilasters have been calculated square to make allowance for the extra trouble in shaping the bricks for them.

Arch Work.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Arch	1	12·518	12·5	1·0	156·475	
Total solid feet arch work, burnt brick and lime....						156·475

String Course, 1st sort.

	N.	L.	Running Feet.	Total Running Feet.
Face walls, including newels and pilasters ..	2	49·00	98·000	
Total running feet string course, 1st sort....				98·000

Coping.

	N.	L.	Running Feet.	Total Running Feet.
To parapets	2	40·5	81·00	
Pilasters	4	2·5	10·00	
Newels	4	2·0	8·00	
Total running feet string course....				99·00

Earthwork.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Filling in between spandril walls	2	9·5	Area 8·50		161·50	
Do. do. do. wing walls..	2	10·0	13·375	5·64	1,508·70	
Roadway over bridge	1	17·00	10·00	1·00	170·00	
Approaches	2	84·6	25·64	$\frac{5·64}{2}$	12,233·972	
Total solid feet earthwork....						14,074·172

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.
295·955 solid ft.	Excavating foundation, a Rs. 0-12-0 per 100 solid feet	Rs. a. p. 9 11 6
1,366·000 „	Filling in do. burnt brick and lime at Rs. 23 per do. do.	314 2 11
1,523·125 „	Superstructure do. do. at Rs. 25 per do. do.	380 12 6
156·475 „	Arch work do. do. a Rs. 32-8-0 per do. do.	50 13 7
98 000 rg. feet.	String course, 1st sort, at Rs. 15 per 100 running feet	14 11 2
99·000 „	Coping at Rs. 0-8-0 per running foot	49 8 0
14,074·172 solid ft.	Earthwork at Rs. 3-8-0 per 1,000 solid feet	49 4 2
Total....Rs.		868 15 10
Add—Contingencies at 5 per cent....		43 7 2
Grand total....Rs.		912 7 0

TAIL SLUICE.

With the sluice is to be connected a road bridge 10' 6" wide between the parapets. The waterway to be in one span of 10 feet, with a rise of 2' 6", and thickness of arching 1 foot; the springing line being 6 feet above the bed of the canal. The abutments are 3' 6" thick, and their foundations, as well as those of the water wings, to be 4' 6" deep, built in 3 steps of 1' 6" each. The up stream water wings are 1' 6" thick at top, 6 feet above the bed of the canal, and 3' thick at foundation. The down stream ones are 1 foot thick at top, 5 feet high, and 2' 6" thick at foundation. The wing walls are 2' 9" thick at foundation, which is on the level of the bed of the canal, and they are built in steps, as shown in the drawing. The arrangement of the pavement is very similar to that of the Tail Sluice Samara Branch, and the regulating apparatus consists of horizontal babool wales and vertical teak baulks. The approaches to be 20 feet wide, with a rise of 1 in 15, and side slopes of $1\frac{1}{2}$ to 1.

CONSTRUCTION.

All the masonry to be of the best burnt brick and lime.

MEASUREMENTS.

<i>Excavating Foundation.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments, including pilasters	2	15.5	5.0	4.5	1,395.00	
Up stream water wings	2	11.0	3.0	4.5	297.00	
Returns to do.	2	2.25	1.25	4.5	25.3125	
Down stream water wings ..	2	11.0	2.5	4.5	247.50	
Returns to do.	2	2.75	1.25	4.5	30.9375	
Wingwalls	4	11.75	2.75	3.53	456.2525	
Newels	4	2.0	5.75	3.53	105.9000	
Pavement in front of gate sill.	1	5.0	9.5	1.5	71.250	
Gate sill	1	8.5	2.5	4.5	95.625	
Pavement from gate sill to end of pilaster	1	13.0	8.5	11.5	165.750.	
Do. portion, 3 feet thick..	1	5.75	8.5	11.5	73.312	
Do. as far as rear curtain wall	1	4.5	9.0	1.5	60.750	
Rear curtain wall	1	10.5	2.0	4.5	94.500	
Total solid feet excavating foundation....						3,119.0895

<i>Filling in Foundation, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total solid Feet.
Abutments, including pilasters	2	15.5	4.5	4.5	627.75	
Up stream waterwings	2	11.0	2.75	4.5	272.95	
Newels to do.	2	2.25	1.25	4.5	25.3125	
Down stream do.	2	11.0	2.25	4.5	222.7500	
Newels to do.	2	2.75	1.25	4.5	30.9375	
Wingwalls	4	11.75	2.5	6.0	705.000	
Newels	4	2.0	3.5	6.0	168.000	
Pavement in front of gate sill	1	5.0	10.5	1.5	78.750	
Gate sill	1	9.0	2.25	4.5	91.125	
Pavement from gate sill to end of pilasters	1	13.5	9.50	1.5	128.250	
Do. portion, 3 feet thick ..	1	6.0	9.00	1.5	81.000	
Do. as far as rear curtain wall	1	5.0	10.25	1.5	76.875	
Rear curtain wall	1	11.0	1.75	4.5	86.625	
Total solid feet filling in foundation, burnt brick and lime....						2,594.625

<i>Superstructure, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Abutments	2	15.5	3.5	6.0	651.00	
Skew backs.....	2	3.25	12.5	0.5	40.625	
Backing	2	12.5	Area 6.00		150.00	
Spandrils.....	4	1.5	Area 8.30		51.00	
Up stream water wings.....	2	11.0	1.75	6.0	231.00	
Returns to do.	2	2.25	1.25	6.0	33.75	
Down stream water wings.....	2	11.0	1.25	5.0	137.50	
Returns to do.	2	2.75	1.25	5.0	34.375	
Wing walls portion.....	4	11.75	2.00	1.50	141.00	
Newels to do.	4	2.00	3.00	1.30	36.000	
Wing walls, portion	4	11.75	1.625	2.00	152.750	
Newels to do.	4	2.00	2.625	2.00	42.000	
Face walls	2	40.5	1.25	1.00	101.250	
Newels to do.	4	2.0	2.25	1.00	18.000	
Parapets	2	40.5	1.00	1.50	121.500	
Newels	4	2.0	2.00	1.50	24.000	
Pilasters, up stream (up to coping).....	2	2.5	1.00	6.00	30.000	
Do. down (do.)	2	2.5	1.00	7.00	35.000	
Total solid feet superstructure, burnt brick and lime....						2,030.75

<i>Archwork, Burnt Brick and Lime.</i>	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Arch	1	12.518	12.5	1.0	156.475	
Total solid feet archwork, burnt brick and lime....						156.475

<i>String Course, 1st Sort.</i>	N.	L.	Running Feet.	Total Running Feet.
Face walls, including newels and pilasters ..	2	49.00	98.00	
Total running feet string course, 1st sort....				98.00

Coping.

	N.	L.	Running Feet.	Total Running Feet.
To parapets	2	40.5	81.00	
Pilasters	4	2.5	10.00	
Newels	4	2.0	8.00	
Total running feet coping....				99.00

Babool Wood.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Horizontal wales	4	10.66	0.66	0.583	16.592	
Filling in pieces	2	6.00	0.66	0.33	2.666	
Total solid feet baboolwood....						19.258

Teak Wood.

	N.	L.	B.	D.	Solid Feet.	Total solid Feet.
Vertical baulks	24	7.5	0.416	0.416	31.250	
Straining pieces	2	6.0	0.50	0.25	1.500	
Gauges (up stream 6' down stream 5')	1	11.0	0.33	0.16	0.611	
Total solid feet teakwood....						33.361

Earthwork.

	N.	L.	B.	D.	Solid Feet.	Total Solid Feet.
Filling in between span-drill walls	2	9.5	Area. 8.50		161.50	
Do. do. wing walls.	2	10.00	13.375	6.97	1,864.475	
Roadway over bridge ..	1	17.00	10.00	1.0	170.00	
Approaches	2	104.55	Mean. 26.97	$\frac{697}{2}$	19,653.403	
Total solid feet earthwork....						21,849.378

ABSTRACT.

Quantities.	Description of Work, and Rate.	Amount.		
		Rs.	a.	p.
3,119·0895 sd. feet.	Excavating foundation, at Rs. 0-12-0 per 100 solid feet	23	6	2
2,594·625 „ „	Filling in foundation burnt brick and lime, at Rs. 23 per do.	596	12	3
2,030·750 „ „	Superstructure do. do. at Rs. 25 per do.	507	11	0
156·4750 „ „	Archwork do. do. at Rs. 32-8-0 per do.	50	13	7
98·00 rg. feet.	String course, 1st sort, at Rs. 15 per 100 running foot	14	11	2
99·00 „ „	Coping, at Rs. 0-8-0 per solid foot	49	8	0
19·258 solid feet.	Babool wood, at Rs. 1-8-0 per solid foot..	28	14	2
33·361 „ „	Teak wood at Rs. 4-4-0 per do.	141	12	7
21,849·378 „ „	Earth work at Rs. 3-8-0 per 1,000 solid do.	76	7	7
Total....Rs.		1,490	0	6
Add—Contingencies at 5 per cent....		74	8	0
Grand total....Rs.		1,564	8	6

Durraïla Branch Recapitulation.

	Rs.	a.	p.
Excavating canal	4,429	5	4
Regulating bridge at head	2,224	4	1
Road bridge in 3rd mile	912	7	0
Tail sluice	1,564	8	6
Grand total....Rs.	9,130	8	11

Miscellaneous Works.

As the canal progressed, it was found necessary to carry out some minor, but at the same time important, works in the shape of subsidiary buildings, which may be enumerated as follows, viz :—

At Bakhora or the Head of the Canal.

Bungalow, with outhouses, and a store room.

At Sindree, now the Head Quarters of the Canal.

Bungalow, with servants' out-houses and stabling.

Quarters for Head Clerk and-quarters for Moonshes.

Pucka well for the use of the Executive Engineer's establishment in the hot weather.

Workshops and timber shed.

Bunneah's shop.

This last work was constructed at the end of 1863 and beginning of 1864, and previous to the location of a Bunneah at Sindree, the nearest place from which grain could be obtained was 6 miles distant, and not only is the settlement of a Bunneah at Sindree a great boon to the Government servants employed at or near that place, but passers by are glad to avail themselves of the permission to make purchases there. Besides the construction of all of the above works, the cost of repairs and conservancy has been charged to the canal itself (it being yet unfinished), and has been met from the different allotments for the years in which these several works have been carried on.

Table showing Cost of the above miscellaneous works.

Names of Works.	Cost.		
<i>Buchora.</i>			
Bungalow and out-houses	Rs. 1,947	a. 5	p. 3
Store room	338	0	4
Repairs to these above works	303	15	8
Current repairs to do.	181	6	3
<i>Sindree.</i>			
Bungalow	5,638	1	3
Out-houses	1,780	1	0
Stabling	353	4	11
Quarters for Head Clerk	536	2	10
Ditto for Moonshes	499	14	10
Workshops and timber shed	303	9	8
Pucka well	466	12	0
Petty repairs to bungalow and out-buildings	131	3	2
Bunneah's shop	30	3	11
Conservancy, Mitrow Canal	4,141	9	11
Grand total....Rupees.	16,651	11	0

ROOTUL BUND.

This work was not included in the original estimate, and was constructed by order of Mr. J. Barns, C. E. (then in charge of the Mitrow Canal), from April to June 1859, in order to prevent some water in the Narra going to waste. The work performed and its cost are given below :—

Quantities.	Description of Work performed.	Cost.		
		Rs.	a.	p.
31,534 solid feet..	Earthwork in bund, including ramming and levelling	95	2	0
	Clearing jungle	11	7	0
	Contingencies and extra establishment....	41	0	0
	Total.... Rupees	147	9	0

NEW WORKS NOT ORIGINALLY ESTIMATED FOR.

Recapitulation.

							Cost.		
							Rs.	a.	p.
Masonry and timber bridge, 9th mile, Mitrow Canal							1,475	2	8
Do.	do.	do.	12th	do.	do.	.....	1,481	11	2
Do.	do.	do.	14th	do.	do.	.....	1,571	4	10
Do.	do.	do.	18th	do.	do.	.....	1,335	7	3
Do.	do.	do.	21st	do.	do.	.....	1,414	3	10
Do.	do.	do.	24th	do.	do.	.....	1,380	8	8
Do.	do.	do.	27th	do.	do.	.....	1,276	13	2
Do.	do.	do.	33rd	do.	do.	.....	1,279	13	3
Do.	do.	do.	37th	do.	do.	.....	1,255	0	2
Do.	do.	do.	40th	do.	do.	.....	1,464	14	10
Do.	do.	do.	48th	do.	do.	.....	1,108	8	6
Do.	do.	do.	52nd	do.	do.	.....	1,077	3	8
Do.	do.	do.	57th	do.	do.	.....	1,055	15	10
Do.	do.	do.	65th	do.	do.	.....	777	11	6
Do.	do.	do.	68th	do.	do.	.....	1,075	6	7
Do.	do.	do.	72nd	do.	do.	.....	1,296	8	7
Do.	do.	do.	75th	do.	do.	.....	1,041	7	4

14 CAN

Recapitulation—(continued).

	Cost.		
	Rs.	a.	p.
Masonry regulating bridge, 79th mile, Mitrow Canal	2,915	11	3
Do. and timber do. 82nd do. do.	1,003	0	11
Do. do. do. 85th * do. do.	1,021	4	3
Do. Tail Sluice	1,492	8	4
Mile stones and bench marks combined.....	1,507	0	6
Bench marks at furlongs	3,680	6	8
Dosah Wah	2,347	8	2
Samara Branch Canal	9,614	1	4
Durraila Branch Canal	9,130	8	11
Miscellaneous.....	16,651	11	0
Rootul Bund.....	147	9	3
New works total.... Rupees	70,879	3	11

<i>General Recapitulation.</i>		Rs.	a.	p.
Works estimated for in the original estimate.....		4,84,452	14	1
Do. not estimated for originally.....		70,879	3	11
Grand total.... Rupees		5,55,332	0	0
Amount of original estimate....		4,22,937	0	0
Excess.... Rupees		1,32,395	0	0

J. D. CRUICKSHANK, Lieut. R.E.,
Acting Executive Engineer, M. C.

J. G. FIFE, Lieut. Colonel,
Acting Chief Engineer in Sind.

*Executive Engineer's Office, Mitrow Canal,
Camp Sindree, 9th May 1866.*

Agricultural Irrigation Canals.

No. 419 of 1866.

PUBLIC WORKS DEPARTMENT.

TO THE OFFICIATING CHIEF ENGINEER IN SIND.

SIR,—I have the honor to forward Estimate No. 19, amounting to Rs. 5,55,332-0-0, of the probable cost of the Mitrow Canal when finished, with its accessory and subsidiary works complete, this sum being made up as follows:—

	Rs.	a.	p.
(1) Works enumerated in the original estimate.	4,84,452	14	1
(2) New works not originally estimated for, and which have been or will be carried out ..	70,879	3	11

2. The original estimate amounted to Rs. 4,22,937, the one now submitted therefore shows a probable excess of Rs. 1,32,395, of which amount Rs. 61,516 is on account of item No. 1, and the remainder for No. 2. As regards No. 1, the excess has arisen partly from the insufficiency of the rate for the excavation, but more on account of the insufficiency of the rate for the masonry works, and from the small sum set down for each kurriah head in the original, viz. Rs. 150. There will probably be now more than 120 heads, whilst in the original only 98 were estimated, viz. 60 in the first division and 38 in the second division of the canal. The details of item No. 2 are given in the estimate.

3. I regret that I cannot now forward the plans for this canal as the tracings of some of them are yet required: they will be forwarded as soon as possible.

4. In apologising for the delay which has occurred in submitting this estimate, besides urging the reason stated in my No. 252, of the 3rd ultimo, I beg to observe that the work has been proceeding since the year 1859, and I have had some little difficulty in finding out all the information necessary to be embodied in this estimate.

I have the honor to be, &c.,

J. D. CRUICKSHANK, Lieutenant, R.E.,

Acting Executive Engineer, M. C.

Executive Engineer's Office, Camp Sindree, M.C., 19th May 1866.

**COMPARATIVE STATEMENT of Estimated and Actual Cost of Works provided for in the Original
Estimate for the Mitrow Canal.**

Description of Works.	Amount in Original Estimate.	EXPENDITURE.			Total.	Saving.	Excess.	REMARKS.
		Already Expended.	Required for Completion.					
		Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
Excavating Canal	2,94,620 6 1	2,70,461 6 5	62,732 14 6	3,38,194 4 11	....	38,573 14 10		Excess caused principally by rise in rates.
Do. Gabrula Branch ..	2,854 0 0	.....	.....	.....	2,854 0 0	....		The position altered and called Durraila Branch in revised Estimate.
Jullub Bund	10,387 0 0	10,753 12 5	.....	10,753 12 5	....	366 12 5		
Weir across Gowud on Mukkee.	43,944 0 0	47,264 8 7	.....	47,264 8 7	....	3,320 8 7		
Regulating Bridge at Bakhora.	8,539 0 0	17,698 11 0	.....	17,698 11 0	....	9,159 11 0		Modified plan sanctioned. The original plan provided for horizontal sleepers and lifting apparatus like that on the Ganges Canal; but it was afterwards thought better to adopt vertical baulks. Excess caused by general rise in rates, especially teak timber. Also from using artificial hydraulic lime for the masonry, which was done by order of the Chief Engineer in Sind.
Masonry Bridge on Road from Mitta Khan-ka-Tanda to Shadadpoor.	4,611 0 0	6,398 13 4	.....	6,398 13 4	....	1,787 13 4		Excess caused by rise in rates.
Do. do. Meerpoor and Kipra road.	4,927 0 0	6,588 5 10	230 0 0	6,818 5 10	....	2,189 5 10		Plan modified, authorized by the Chief Engineer in Sind. Excess caused by rise in rates and alteration in plan.

Description of Works.	Amount in Original Estimate.	EXPENDITURE.			Saving.	Excess.	REMARKS.
		Already Expended.	Required for Completion.	Total.			
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	
Masonry Bridge Meerpoor and Oomenkote Road.	3,675 0 0	5,174 2 0	.....	5,174 2 0	....	1,499 2 0	Plan modified. No authority. Excess caused by rise in rates and alteration in plan.
Do. do. Samara and Gorechancee.	3,164 0 0	2,230 9 9	1,700 0 0	3,930 9 9	....	766 9 9	Plan modified. No authority. Excess caused by rise in rates.
Do. do. Jooda to Nubbesur.	389 12 9	.....	.....	.....	389 12 9	....	(Omitted, and bridge at 85th mile (see revised Estimate) substituted.
Do. do.	389 12 9	.....	.....	.....	389 12 9	....	
Escape at Karora	1,024 11 9	.....	2,466 14 11	2,466 14 11	....	842 3 2	This was to have been constructed in the 62nd mile, but as there has been a slight change in the direction of the canal, it will now be in the 66th mile.
Masonry heads to Kurriahs ..	14,700 0 0	11,713 6 2	39,039 5 2	50,752 11 4	....	12,532 11 4	It was considered advisable to increase the number of masonry heads to kurriahs, and regulate the water with them alone in place of having modules. Excess caused by rise in rates.
Modules for setting water	23,520 0 0	.....	.....	.....	.....	....	Not now required, as the direction of the canal is changed, and its navigation is not connected with the Silhoorwah.
Lock into Silhoorwah	5,591 1 7	.....	.....	.....	5,591 1 7	....	Entered under the head of miscellaneous works (see page 85).
Extra Establishment and Contingencies.	.....	.. ..	.....	.....	....	....	
Total....Rupees.	4,22,936 12 11	3,78,288 11 6	1,06,169 2 7	4,84,453 14 1	9,224 11 1	70,740 12 3	

J. G. FIFE, Lieut. Colonel, R. E.,
Acting Chief Engineer in Sind.

STATEMENT OF NEW WORKS NOT ORIGINALLY ESTIMATED FOR.

Mitrow Canal.

Works.					Cost.			Re- marks.
					Rs.	a.	p.	
Masonry and timber bridge, 9th mile, Mitrow Canal...					1,475	2	8	Unauthorized. Completed.
Do.	do.	12th	do.	..	1,481	11	2	
Do.	do.	14th	do.	..	1,571	4	10	
Do.	do.	18th	do.	..	1,335	7	3	
Do.	do.	21st	do.	..	1,414	3	10	
Do.	do.	24th	do.	..	1,380	8	8	
Do.	do.	27th	do.	..	1,276	13	2	
Do.	do.	33rd	do.	..	1,278	13	3	
Do.	do.	37th	do.	..	1,255	0	2	
Do.	do.	40th	do.	..	1,464	14	10	
Do.	do.	48th	do.	..	1,108	8	6	
Do.	do.	52nd	do.	..	1,077	3	8	
Do.	do.	57th	do.	..	1,055	15	10	
Do.	do.	65th	do.	..	777	11	6	
Do.	do.	68th	do.	..	1,075	6	1	
Do.	do.	72nd	do.	..	1,296	8	7	A
Do.	do.	75th	do.	..	1,041	7	4	
Masonry regulating bridge		79th	do.	..	2,915	11	3	
Masonry and timber bridge		82nd	do.	..	1,003	0	11	Not yet commenced.
Do.	do.	do.	85th	do.	1,021	4	3	
Masonry tail sluice					1,492	8	4	
Mile stones and bench marks combined					1,507	0	6	B
Bench marks at furlongs					3,680	6	8	
Dosah Wah					2,347	8	2	
Samara Branch Canal					9,614	1	4	Authorized.
Duraila Branch Canal					9,130	8	11	
Miscellaneous					16,651	11	0	
Rootal Bund					147	9	3	
					70,879	3	11	

J. G. FIFE, Lieutenant Colonel, R.E.,

Acting Chief Engineer in Sind.

No. 3628 of 1866.

PUBLIC WORKS DEPARTMENT

To the SECRETARY TO GOVERNMENT,

Public Works Department.

SIR,—Agreeably to Government Memorandum No. ^{122 C. W.}_{255 M.} dated 1st February last, and previous orders, *vide* Government Memorandum No. 575, dated 13th March 1865, on the subject of the Mitrow Canal, item No. 174, Part II. of the current year's Budget, I have the honor to forward a revised estimate with seven plans, and an explanatory letter, No. 419, dated 19th May last; from Lieutenant Cruickshank.

2. The original estimate for the Mitrow Canal amounted to Rs. 4,22,937; the revised one now submitted amounts to Rs. 5,55,332. An analysis showing the items on which the excess has been incurred is attached. It will be observed from it, that the excess on works provided in the original estimate amounts to Rs. 61,516 only, while that for works not provided for amounts to Rs. 70,879.

3. The Mitrow Canal was commenced in the month of March 1859, and has passed through many hands. Mr. Barnes, C. E., Captain LeMesurier, Lieutenant Smith, and Lieutenant Cruickshank have severally had charge of the works. Captain LeMesurier and Lieutenant Smith however have performed by far the largest share, each of these officers having held charge for about three years without interruption. Till the period when Captain LeMesurier gave over charge, the works appear to have been conducted without any irregularity; but from that period I regret to report that Lieutenant Smith appears to have forgotten that the sanction of superior authority was always necessary for alterations to sanctioned works, or the construction of additional ones. The line of the canal was considerably departed from towards its tail, an alteration of which I, who both surveyed the ground and fixed the terminus, disapprove,

and no less than 14 bridges of cross communication have been built in addition to those provided in the original estimate. The bridges are about 3 miles apart, and considering that the canal is only 6 feet deep, and that it runs through a tract so thinly populated as to almost deserve the name of desert, I think the provision too extravagant. On the ordinary canals in Sind bridges are few, and both people and cattle are accustomed to swim across. However, the point I regret to have to bring to notice, is Lieutenant Smith's carrying out these works without authority. I also observe that alterations have been made in some of the bridges originally designed; the head way for boats having been somewhat reduced, a matter which we shall some day have cause to regret.

4. Lieutenant Cruickshank succeeded Lieutenant Smith in June 1865, and upon this officer has fallen the very laborious business of preparing the revised estimate, which has been of course rendered more than usually troublesome from the numerous departures, authorized and unauthorized, which have been made from the original plans, and the long period over which the execution of the work has extended, now seven and a half years.

5. I cannot say that the revised estimate and plans are as nicely prepared and complete as they should have been; but there has been so much difficulty in getting clerical work done on the Narra, where the Executive Engineer has frequently to change his ground, and where the health of the subordinate establishments suffer much from exposure, and sometimes from want of good supplies, that I must beg Government to overlook the want of completeness in the plans, &c. The original plans and estimates do not appear to have been ever returned, when sanction to the work was accorded; but I have compared the revised estimate with the office copy of the original one. I have also examined the office copies of the following plans, which cannot be spared by the Executive Engineer at present:—

Longitudinal Section of Canal.

Bungalow at Sindree.

Out-houses at Sindree.

Stables at Sindree.

6. The increase of rates, which is one cause of the excess over the original estimate, was of course to be expected ; but it is not great, as in preparing the original estimate, a considerable margin was allowed against such a contingency.

7. The excess on the kurriah or branch heads which is alluded to in the 2nd paragraph of the Executive Engineer's explanatory letter No. 419, dated 19th May last, is really not so great as that officer's letter implies. In preparing the original estimate, it was of course impossible to fix precisely the number of masonry heads to provide for the distribution of the water, as it cannot be foreseen to how many different Zemindars the water will have to be separately distributed. Indeed, in the case under consideration, the country through which the canal had to be carried, was simply a desert without any population. In framing the original estimate therefore, an approximate allowance for branch heads and minor masonry distributing heads was made, which was as follows :—

Masonry branch heads.....	Rs. 14,700
Modules	„ 23,520

Rupees 38,220

When the land settlement was made, and the water came to be used, however, a somewhat different mode of distributing the water was adapted. Instead of a simple branch head with masonry modules at intervals, the branch head was made to regulate the supply, and the modules were dispensed with. Each Zemindar was provided with a “kurriah” head, as it is called in Sind, in the bank of the main canal. There are therefore more heads in the canal bank than were contemplated, and they are of a more complicated construction, but the modules were dispensed with.

8. I have made these remarks to explain what is evidently a misconception on the part of the Executive Engineer. I do not express any opinion as to whether the arrangement adopted is better than that first contemplated, nor at the same time do I find fault with the Executive officers for not having strictly followed the system

first contemplated. The best mode of distributing water on flat countries like Sind, where "loss of head" cannot be afforded, is by no means a settled question yet. My own views, based on the best information I could obtain, were reported to Government about three years back, when I was in the Deccan. The subject is too long to enter upon here; but I hope to resume it after I have visited the Mitrow Canal again.

9. In concluding this letter, I should not omit to mention one important fact, which I hope Government will accept as an excuse for the irregularities I have been obliged to report. Ever since the first commencement of the canal in 1859, it has been in actual use for irrigation. The country through which it had to pass was a perfect desert, and it was desirable to admit the water to the excavation, and lead it along both for drinking purposes, and to give the people the benefit of the irrigation as quickly as possible. The excavation was carried on in parallel trenches, one at a time being used for the water. This plan, undoubtedly a most beneficial one to both the people and to Government, has of course added considerably to the labours of the executive establishment, and kurriah heads and additional bridges of communication became desirable, if not absolutely necessary, before the Executive Engineer had the degree of leisure which would have been afforded to him had he been merely constructing, and not also actually working, a canal. I trust Government will remember this important fact, and not be too severe in censuring Lieutenant Smith, who assumed charge when the irrigation was rapidly increasing. The whole of the officers, including Lieutenant Smith, have worked in the most devoted manner in carrying on the works in the face of difficulties arising from scarcity of labour, and scanty shelter for themselves and their establishments, and much personal discomfort, if not hardship, which a residence in a desert district necessarily entails.

10. I should not omit to mention here, that the Political Superintendent, Captain Tyrwhitt, has rendered great aid in the prosecution of the excavation of the canal during the past two years, by placing a large body of convicts upon the work.

11. The following is a statement showing the area of irrigation and the revenue derived from the canal for each year since its commencement :—

Year.	Length of Canal open in Miles.	Area irrigated, in Acres.	Revenue.	Remissions.	Revenue Collected.	REMARKS.
			Rs.	Rs.	Rs.	
1860-61	....	....	10,167	None.	10,167	
1861-62	29	23,666	48,669	Do.	48,669	
1862-63	38	40,841	49,185	Do.	49,185	
1863-64	70	49,749	67,679	43,863	23,816	Great damage caused by locusts.
1864-65	74	42,547	49,563	12,276	37,287	New water measurement and Revenue system introduced which failed.
1865-66	80	....	....	....	....	Returns not yet received.
Total..	191	156,803	2,25,263	56,139	1,69,124	

12. The revenue which has been obtained from the canal has not caused a falling off in the neighbouring district to the westward. It is said that people have come from the Eastern Desert to cultivate. The number is small as yet, but as the water flows without a lift into the fields, and there is ample room for fallows, the labour of the cultivators goes a long way. The cultivation is indifferent, as might be expected, and on rice lands the ground is not always ploughed, and the seed is sown broadcast. But time will no doubt bring improvement in this respect, and with better management of the water, which

is at present wastefully used, the revenue will greatly increase. It is anticipated that the canal will be completed during the approaching year.

I have the honour to be,

Sir,

Your most obedient Servant,

J. G. FIFE, Lieutenant Colonel, R.E.,

Acting Chief Engineer in Sind.

Chief Engineer's Office, Kurrachee,

8th November 1866.

P.S.—There are several works, from A to B in the Statement attached, “not originally estimated for,” which are not yet executed, and it is possible, that when I have an opportunity of visiting the canal, I may be able to decide that, with the exception of the milestone benchmarks, they are not necessary; but I cannot detain the estimate any longer. The estimated cost of the works is Rs. 13,526.

J. G. FIFE, Lieutenant Colonel, R.E.,

Acting Chief Engineer in Sind.



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on 27 November, 2018

